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FUNCTIONAL EAR EXAMINATIONS IN PATIENTS WITH MENIERE'S SYNDROME.

REPORT OF CASES.*†

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It was some seventy years ago when Meniere brought forth convincing clinical evidence that disturbance of the inner ear could produce the well-known group of symptoms that are associated with his name. And his autopsy findings went a long way towards revising the opinion of the time, which was that the ear served solely as an organ of hearing to that of the acceptance of its dual function: cochlear-exteroceptive, vestibular-proprioceptive. Meniere's achievement on the clinical side was preceded by thirty years by the discovery of this new receptor in experimental animals by Flourens. This knowledge has led to a modification of those early conceptions that the symptoms we associate now with a labyrinthitis or with other labyrinthine disease were caused solely by intracranial lesions, either primary or secondary to ear infections. It disproved also the opinion of Purkinje that the reactions

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†From the Department of Otolaryngology, College of Physicians and Surgeons, Columbia University. The examinations and operations not specifically related to the ear, nose or throat were performed in their respective departments.

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of the rotation test were produced by a stimulation of the cerebrum without the interposition of an end-organ and its nerve. The isolation of this new receptor opened a noteworthy program that has not ended, involving both experimental and clinical investigations into the nature of the vestibular mechanism: its end-organ structure, its central pathways and connections, its function and the methods of its examination.

We wish here to consider the clinical application of the vestibular tests along with the cochlear tests in a small group of patients with Meniere's syndrome. It will be seen that none of these patients had Meniere's Disease. The functional ear examination is simply one of the many procedures carried out in an investigation to determine upon the cause of those disabilities that are referable to the ear or to the vestibular mechanism as a whole. We will agree, I am sure, that the usefulness of this examination as an aid to clinical diagnosis depends upon the evaluation of a correct interpretation of the ear tests along with the other available evidence in a given patient.

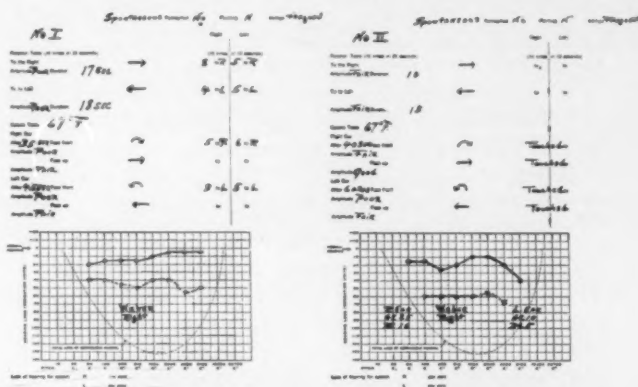
The charts are presented because the findings are more readily followed than if they were given in the text. There is related only the pertinent information in the history and examination of each patient.

Case 1: J. G., man, age 45 years. Dizziness, buzzing and deafness in the left ear for one week. History of frequent head colds. A very slight vestibular impairment was noted in the amplitude of the nystagmus and the difference in the degree of irritability of the two sides to temperature. Hearing was impaired in the left ear. Weber-right. Both ear drums were moderately retracted and vibrated poorly, the left more than the right, on alternating pressure in the external canals. A large polyp was present in the left ethmoid region. A moderate amount of adenoids was present and there was congestion about the orifices of both Eustachian tubes. The left Eustachian tube was partially obstructed. His symptoms subsided without any recurrence following a single inflation of the Eustachian tubes.

One might expect Meniere's syndrome to occur frequently as a result of insufficiency of the Eustachian tubes in indi-

viduals subjected to sudden variations in atmospheric pressure. I have examined aviation personnel for several years and can recall only one flyer in whom there was a suspicion that he suffered of this condition even in a mild form. However, some of the unexplained fatalities in aviation may have been caused by a disturbance of equilibrium resulting from a lack of patency of the Eustachian tubes.

Case 2: C. F., man, age 52 years. Frequent dizzy spells with nausea and vomiting. Deafness in left ear. Buzzing in both ears. Duration, three months.



Psychotherapy for three months had given no relief of his symptoms.

Vestibular reactions were slightly impaired in the left ear. Hearing was impaired in both ears, left more than right; perception type.

Ears appeared to be normal. A right antral infection was present. The antrum was irrigated over a period of three weeks with a definite relief of his symptoms. A large opening was made in the right antrum at this time. The antral infection and vertiginous spells subsided. There was very slight improvement in his hearing. In our experience infections of the sphenoid sinuses are associated more frequently with Meniere's syndrome than that of any other of the nasal accessory sinuses.

was dark on transillumination. Left antrum was irrigated and the return was clear.

Urine showed glucose 2 plus. No acetone or diacetic acid. Blood sugar 148 mg. per 100 cc.

His blood sugar became normal under treatment. The vertigo ceased, but there was no improvement in his hearing.

Comment: It has been my experience that the examination of the majority of patients with Meniere's syndrome conforms to the findings in the four cases shown in that they have no inflammatory disease or traumatic lesion of the ears, no positive evidence of disease of the central nervous system, either by functional ear testing or general neurological examination.

The cochlear function seems to suffer more than the vestibular function if one may make a comparison on the results of the tests. Although this would be in agreement with the accepted opinion on the comparative vulnerability of the cochlea and vestibule to both toxic and traumatic effects, I think that here the tinnitus present must be reckoned with in estimating the cochlear damage by the hearing tests.

All of us know that the therapeutic results are not so beneficial as might be inferred from these few cases. For at times the most searching examination by the internist, neurologist and otologist fails to discover the cause of these symptoms that are so distressing to the patient.

Case 5: E. F., woman, age 30 years. Dizziness with nausea and vomiting. Buzzing and deafness in the right ear. She had suffered a severe head injury twelve hours before I saw her.

The neurological findings had suggested a basal fracture. There was a marked horizontal nystagmus to the right, and left gaze decreased the nystagmus, vertigo and nausea. A small amount of dry blood was in the right external canal. The limited examination possible at this time showed that some hearing was retained in the right ear. The retention of some hearing along with the direction of the nystagmus provided sufficient information for one to conclude that the right inner ear had not been destroyed and that improvement in hearing would likely occur. The direction of spontaneous nystagmus to the side of the ear injured, as in this

taneous vestibular phenomena present and by such testing as is possible of the hearing.

In Case 6 an examination at the time of injury most probably would have shown total deafness on the right side and nystagmus to the left with vertigo, nausea and vomiting. With those findings one would give a guarded prognosis for functional recovery until the patient's condition permitted a more detailed examination.

Case 7: F. G., man, age 34 years. Dizzy attacks, deafness and noises in the right ear and headaches for five weeks. Recurrent drainage from right ear for ten years.

Vestibular reactions showed poor past pointing and a vertical nystagmus upward in the face up position on caloric test of the right ear. A qualitative reaction of this type makes one pretty sure of the presence of a lesion of the brain stem, either as a direct involvement or through pressure. Hearing was slightly impaired in the right ear.

There was a small foul discharge coming from a marginal perforation in the attic region of the right ear. X-ray examination of the mastoids showed the right to be sclerosed.

A neurological examination at this time did not reveal any evidence of a focal lesion in the brain. Two days later, however, a neurological examination gave the impression of a right temporal lobe abscess. A lumbar puncture was done at this time. The spinal fluid was under pressure and the cell count was 50 lymphocytes. The patient died a few hours later, presumably from the result of the lumbar puncture. The evidence here indicates the presence of a brain abscess.

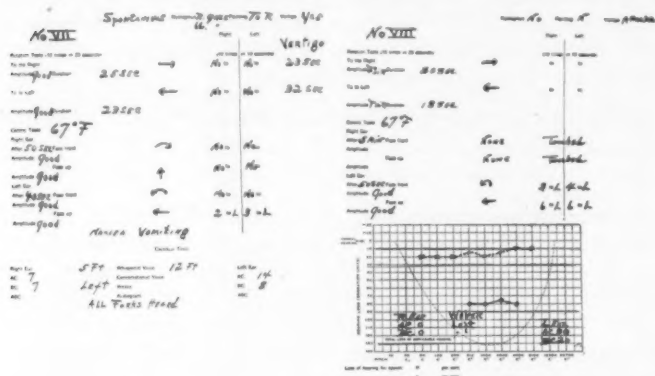
Comment: Meniere's syndrome occurring along with a purulent middle ear infection usually is an indication for an ear operation. The operative procedure determined upon depends on the condition of the inner ear and whether or not there is any evidence of an intracranial extension of the infection. The cochlear and vestibular tests in addition to giving dependable information on the inner ear condition in such patients, may give some signs of an intracranial complication.

The functional ear examination in this case indicated a focal brain lesion before the more general neurological symptoms appeared.

Case 8: F. B., boy, age 8 years. Dizzy spells with nausea and vomiting. Deafness in the right ear. Slight headaches.

A right simple mastoidectomy had been done three years ago and after five days of normal convalescence his temperature rose to 102° , and he had persistent vomiting for ten days. When the acute symptoms subsided he experienced difficulty in walking for a while. Following this he was free of any complaint for over two years. Then the present symptoms began to occur. In the intervals between the spells he felt quite well.

Vestibular reactions were lost on the right side. Hearing was lost in the right ear. The ears appeared to be normal. No signs of a mastoid infection were present.



The autopsy showed an old abscess on the right side involving the inferior peduncle, pons and upper part of the medulla, with erosion of the petrous ridge.

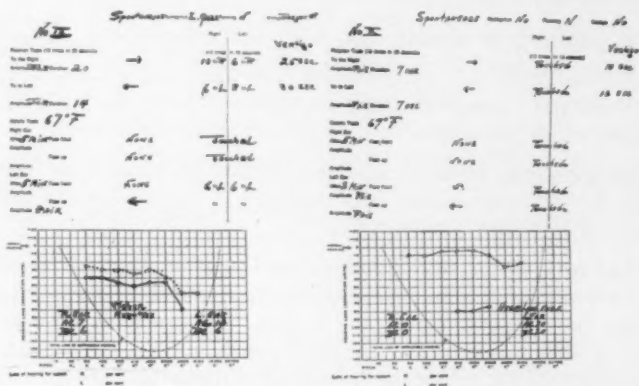
Comment: The sequence of the symptoms and the findings on examination suggest that this patient had an acute labyrinthitis just following his right mastoidectomy and that the more recent disability, which was so similar to labyrinthine crises, was caused by an intracranial disease. The right vestibular nucleus was involved along with some other structures in the abscess found on autopsy. There is no clinical or experimental proof that I know of showing that it is possible for a vestibular nuclear lesion on the side of a pre-

viously destroyed inner ear to cause a recurrence of the phenomena of disequilibrium as produced by a sudden loss of one ear function. Such a possibility is suggested in this case.

Case 9: T. M., man, age 59 years. Tinnitus and progressive impairment of hearing and occasional dizzy spells for four years.

Vestibular reactions were lost on the right side and impaired on the left.

Hearing was impaired in both ears, right more than left; perception type.



Ear drums were moderately retracted. There was a moderate obstruction of both Eustachian tubes and a congestion about their orifices.

The findings suggested the presence of a right eighth nerve tumor, but the neurological examination did not warrant this diagnosis. The functional examination was repeated, two weeks having intervened. My latter note was: "Today there is a very good nystagmus on the right ear caloric test and poor on the left ear caloric test. I cannot account for these changes in the degree of irritability of the vestibular nerves since the last examination on any ear pathology. The findings today are not consistent with those obtained in the presence of an eighth nerve tumor." The neurological findings were sufficiently suggestive of an intracranial expanding

lesion to warrant an encephalogram for the purpose of localizing it. The encephalogram showed a mild bilateral cerebral atrophy. The final diagnosis was arterio-sclerosis with cerebral atrophy.

It is advisable to repeat the functional ear examination when the findings are suggestive of an abnormal intracranial condition that is not confirmed by a neurological investigation.

Case 10: E. B., woman, age 30 years. Tinnitus and progressive loss of hearing in the right ear for three years. Mild vertiginous attacks. Inflations of the Eustachian tubes, treatment for a low grade sphenoid sinusitis and electrotherapy had not given any relief.

A neurological examination prior to the functional ear tests revealed evidence of a right acoustic nerve tumor.

Vestibular reactions were absent on the right side and impaired on the left.

Hearing was greatly impaired in the right ear. Ear, nose and throat examination was normal. A right acoustic neuroma was found on operation.

The early subjective disturbances of acoustic nerve tumors are almost invariably deafness, tinnitus and at times vertigo. From the onset of symptoms it may be a duration of years before structures in the posterior fossa are involved to the extent of giving any other subjective symptoms. The history of this patient is quite typical: deafness, tinnitus and vertigo for a few years, Eustachian tube inflations and treatment of some nose or throat disease present. The complaint being referable to the ear, relief is sought from the otologist. The physical and functional ear examination provides sufficient evidence of the condition present to warrant a thorough neurological investigation and early in the growth of the tumor when the chances for cure are most favorable. In no other intracranial disease is the otologist so likely to make a correct diagnosis solely on the ear examination.

20 East 53rd Street.

A CONSIDERATION OF THE RECURRENT MASTOID.*

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The recurrent mastoid has received scant consideration in our textbooks and literature. It is usually described as a rare condition, but the author feels that it is more prevalent than is conceded. In a series of fifteen mastoidectomies done within the last three months, on the nose and throat service of Dr. T. B. Wood, at the Coney Island Hospital, four were recurrent mastoids; and one of this group had been subjected to four previous operations. How little attention is given to this subject may be inferred from the fact that Politzer, in his authoritative text on "Diseases of the Ear," omits it entirely from consideration. Current ideas are, likewise, confusing and inaccurate. To many it is merely a "blow out," a subcutaneous abscess whose treatment calls for incision and drainage. For instance, Levine in his "Practical Otology" states, "When these measures fail (*i. e.*, myringotomy and suction with a simple rubber bulb) and the mastoid scar continues to swell, an incision should be made under local anesthesia, and a simple drain inserted into the wound."

The first references on the subject to appear in the literature were made by Israel, of Turin, who in 1901 described the condition and quoted five cases. Most of the work has since been done by foreign writers. In our own country, McKernon in 1906 stressed the idea of the incomplete operation as the principal cause for recurrences. In 1928, H. I. Lillie presented fifty cases, and again emphasized the importance of complete surgery. H. S. Muckleston in 1930 added several interesting cases to the literature.

First of all, what is meant by the term "recurrent mastoid"? It is necessary to be explicit, because in the writer's opinion much of the confusion on the subject is due to lack of agreement, not only on terms, but on differentiation of ideas. Let it be said then, that the recurrent mastoid infers that the

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primary mastoid condition has been entirely cured, that an interval of, as a rule, several months or years elapse, during which the patient is entirely free of ear disability, before a second attack occurs. I stress the point of complete recovery, because should any sign of inflammation continue — as a retroauricular fistula, or exudate from the ear, or impairment of hearing — and be followed by a second attack several weeks or months later, the second condition could not be accurately regarded as a recurrent, but an “unresolved” mastoid.

To fully appreciate the subject, it is necessary to have an idea how the mastoid process heals after an operation. Much light has been thrown on the subject by experimental operations on animals. Samoylenko, of Petrograd, in 1913 operated on the frontal sinus of cats and dogs, and noted the filling in of the postoperative bony cavities. Obliteration is generally complete towards the fifth or sixth month; with others, it may exist one month after the operation. The fibrous tissue which fills the cavity is tougher, the more removed the date from time of operation. The mucosa having been removed, periosteum fills in the cavity. Microscopic examination reveals, at the end of six and one-half months, numerous bony trabeculae, together with new formed blood vessels, in the periphery. Centrally, periosteum is found. It forms the essential role in the postoperative obliteration of the cavity. Mouré, in the same year, studied the postoperative filling of the mastoid process, after antrotomy. His subjects were two rabbits. These have a large cell, which almost fills the whole mastoid process. In the first, this cell was opened and curetted carefully. The skin was sutured directly without drainage. The animal was killed at the end of six days. The operated area was found in part filled with new formed cicatricial tissue. The second animal was operated in the same way, but in the cavity a drain was placed, which was removed at the end of fifteen days; the rabbit was sacrificed after forty-five days. The mastoid process was entirely filled; the bony perforation had completely disappeared.

In man, these phenomena are identical. New formed fibrous tissue at first fills all of the operative cavity. Bony restoration occurs later, more or less quickly, and more or less completely, coming from the bony surface and from the periosteum. With a child whose periosteum has a considerable osteogenic power

repair will occur more rapidly, and also the chances of it being total will be better than in the adult. In very exceptional cases a complete restoration of the outer table with reformation of cellular structure has occurred.

The author recently had the good fortune to operate at the Coney Island Hospital on such a rare case. A child, age 4 years, who had had a left mastoidectomy three years ago, was admitted, complaining of pain in the left ear of one week's duration. Examination revealed a subject not acutely ill, temperature 100.4°, redness, tenderness and swelling over the old mastoid scar, with forward displacement of the auricle. At operation, pus was found in the soft tissues. On retraction of the periosteum, an intact outer table was seen, with fine sieve-like openings overlying the antrum. In fact, there was nothing to indicate from its appearance that it had been previously operated upon. On opening the outer table with a gouge and mallet, pus and granulation tissue was found in a small cavity, which communicated with the antrum. Convalescence was rapid and uneventful. It was surprising to note the slight constitutional reaction in the presence of a complete bony restitution.

More common than the complete is a partial bony regeneration with new connective tissue. The most common event, however, is the filling in of the wound with granulation tissue, then scar tissue. The skin wound is finally depressed somewhat by the contraction of the scar. In practically every case an antrum is reformed, though somewhat reduced in size.

What is the significance of the cellular structure found in the recurrent mastoid? First of all, very few operators, in the average case, advisedly remove all cellular structure at the time of the original interference. Not all of the cells are involved by disease, and, as a practical consideration, it is very difficult to exenterate every infected cell in the mastoid. Secondly, cells normally develop in the mastoid during the formative period. A child operated on at one year of age can still develop a partial pneumatic mastoid. Finally, a certain amount of regeneration of cells does occur following operation. I am laying stress on the varied origin of cellular structure in the operated mastoid, because it is necessary for a proper appreciation of the findings at a subsequent procedure. Some otologists feel that the finding of cells at a later inter-

vention is proof positive of the neglect of their predecessor in performing complete surgery.

The etiology of the recurrent mastoid has long been a debatable subject. The idea that a previous incomplete operation is largely responsible has probably won the greatest number of adherents. McKernon in 1906 was one of the first to champion this cause. He states: "The principal cause for an infection taking place from the mastoid itself is that during the first or subsequent operations, all of the diseased bone has not been removed, and this area is at first covered by granulations that look healthy. These areas in the mastoid bone that cause such tardy and prolonged healing may occur in any part of the mastoid cavity, but their usual sites are, first, the anterior portion of the zygomatic root, which overhangs the entrance of the aditus into the middle ear; the second site is the posterior root of the zygoma; the third site is that portion of bone lying over and behind the sigmoid groove; the fourth is the mastoid tip; and the fifth is the middle ear, involved in a chronic purulent lesion." Wolff in 1907, before the Berlin Otological Society, argued for the persistence of latent germs at the bottom of the mastoid scar, which are reactivated by an infection from the middle ear.

H. I. Lillie in 1928 reported fifty cases of subsequent reinfection of the ear and mastoid. "In all the cases it was found that the mastoid cells had not been operated on completely. Myringotomy and drainage of the mastoid scar, after suppuration, will effect rapid cure if the operation on the mastoid process has been complete."

The author believes that too much stress has been laid upon the idea of a previous incomplete operation. How can we believe that a recurrence, say five or ten years later, during which entire period the patient was completely free of symptoms, can be due to some infective material which was not removed? It is not an uncommon experience to witness complete and lasting recovery in cases of definite surgical mastoiditis, who have refused operative interference. It is, likewise, a known fact that Nature can take care of minute infection and heal it. W. P. Eagleton, in an article on "The Reconstruction of the Mastoid Wound Cavity, by the Use of Bone Grafts and Chips," says: "While absolutely complete eradication of all infection from a mastoid region is impos-

sible, if the operative evisceration is carried well beyond the apparently infected area, the tissue will take care of the slight amount of infection which may remain." Assuredly, in those cases where recurrence follows shortly after the operation, residual infection plays an important part. These are, for the most part, cases of unresolved mastoid. The finding of infected cells, at the time of reoperation, has contributed to the idea of incomplete surgery as the cause of recurrences. These cells owe their origin in part to regeneration or to normal development of pneumatic structure and, in my opinion, the infection of these cells does not date back to the time of the original operation, but to the onset of the new attack.

The essential factor in the recurrence of mastoid disease is the development of an acute infection. In other words, the same factor, which gave rise to the previous attack, as an upper respiratory infection, or in children, any of the exanthemata, is directly responsible for later recurrences.

Added to this direct agent are the predisposing factors of mastoid susceptibility, adjoining foci of infection, constitutional infirmity and faulty operative technique. A mastoid that has once been opened falls more readily a prey to later infection. Such an infection when it gains a foothold on the middle ear can extend more readily to the mastoid, because of the lessened resistance offered to the invader by scar tissue. Even when new bone is formed, it is less resistant than the original, and breaks down more readily. A chronic suppurating otitis media, by constant reinfection of the mastoid, will contribute to recurrences. Hypertrophied and diseased adenoids and infected sinuses are likewise culpable. Malnutrition, especially in children, is often the disturbing factor in upsetting the balance when an acute infection sets in. Children are more often subject to recurrences than adults. But the same applies to the original attack. Perhaps the reason for this is that they are more prone to nasopharyngeal involvement with resultant extension to the ears, and because their Eustachian tubes are more transverse and patulous, sucking in infection more readily.

There are some features in the operative procedure which predispose to recurrence. Kopetzy holds that the mucous membrane which lines the aditus ad antrum and the antrum, in the presence of infection, is capable of swelling to many

times its normal thickness, and producing a thick gelatinous mass which fills the aditus and antrum opening. Some operators in their anxiety to remove every trace of infected material, not only remove this mucous membrane, but also enlarge the bony framework of the aditus and antrum. This mucous membrane, if undisturbed, returns to normal and is in direct contiguity with that of the tympanic cavity proper. It is the best protection that can be given to the newly formed connective tissue which fills the mastoid shell.

I wish to add to this idea of a swollen mucous membrane, as a mechanical block to the spread of bacteria, the value of normal mucosa as a defense mechanism. The subject of local immunity has of late received considerable attention. The value of normal mucous membrane over connective tissue has been definitely established. Linton states: "Infection invariably results, with participation even by weaker pathogens, when mucus secretion has been greatly reduced or is absent. . . . Likewise, mucus secretion makes possible the surface activity of phagocytes, which many claim to be the principal defensive agents."

The value of the blood clot dressing as a prophylactic measure against recurring mastoiditis has never been scientifically demonstrated. When the clot does not break down from infection, healing of the wound is rapid and painless, and the resultant scar is very fine and not depressed. The clot provides a framework on which the new granulation can more readily take hold. Likewise, it seems to aid in new bone formation, as osteoblasts can extend further from the bony wall into the central granulating area. Theoretically, therefore, it would seem that the blood clot dressing provides the nearest approach to a restoration of the mastoid to its former condition. A secondary blood clot dressing done after the mastoid infection was largely controlled would undoubtedly attain a larger per cent of successful end-result. If the conservative treatment of the mucous membrane of the antrum and of the aditus were added to this, we would have, perhaps, the most effective barrier against the spread of infection from the middle ear.

The clinical types of recurrent mastoid conform largely to the mode of anatomic repair. In the common type of healing, by connective tissue, the clinical picture is classic. This is

the type of recurrent mastoid that is referred to as a "blow out." Following an attack of upper respiratory infection, the patient suffers an earache, which may be very mild. His condition is such as to, in his opinion, hardly warrant bed confinement. Temperature is normal, or slightly elevated, but in a few days the condition rapidly localizes behind the ear. Just as the constitutional symptoms are not marked, the local objective signs are in full bloom. There is marked redness, tenderness and swelling of the scar with evidences of fluctuation. Following incision and drainage, convalescence is rapid and uneventful.

In the type where the cellular development of the recurrence is abundant the clinical picture may simulate an original mastoid. The temperature and constitutional signs may be well marked, pain severe, and intracranial complications an event with which to contend. For a long time this cellular type may not show the typical swelling and fluctuation behind the ear. Because this sign occurs regularly in the usual type, it would be a serious error to postpone surgical interference until its appearance, for by so doing the chances of a serious complication are increased. The author recently attended such a case, where intervention was indicated before the advent of a fluctuating scar. A child, age 3 years, had the right antrum curetted at the age of nine months by the writer. There were no other cells developed at the time, and following antrotomy she recovered promptly. Very recently, following an upper respiratory infection, she developed an otitis media on the right side which was treated by myringotomy and suction. She was doing very nicely until suddenly the temperature became elevated, rising as high as 104° , discharge became profuse, and the child was unable to sleep because of severe pain. An X-ray of the mastoid revealed cloudy cells. The mastoid clinically showed slight redness but no tenderness or swelling. At operation, the infected cells were curetted, and the child made a prompt recovery.

A third type is where bony regeneration of varying amount occurs, with or without cellular development. Here the course is apt to be less rapid, and the constitutional reaction more pronounced than in cases of scar tissue repair. I do not wish to leave the impression that these clinical types are sharply demarcated. Most often they are of a mixed nature.

What is the picture of the middle ear? As in the original mastoid, it may vary from a slight injection of the drum to a full blown abscess. But a characteristic feature in recurrences is the remarkably little pathology that seems to be present in the middle ear in the face of a fully developed mastoid. Perhaps because of the altered anatomy in the mastoid, resolution of pathology in the middle ear may occur while it is progressive in the mastoid.

The prognosis of the recurrent mastoid is, on the whole, more favorable than in the original condition. In those cases where healing is by scar tissue, and they are in the majority, the prognosis is good because the infection readily reaches the skin. Where considerable bone has reformed, or cellular structure is present, the prognosis may be less favorable. That it is not always a simple affair is indicated by references in the literature of complications fully as serious as in the former intervention. Samuel Iglauder reported a case of bilateral recurrent mastoiditis with sinus thrombosis and secondary infection of the jugular vein. Hugh B. Blackwell described a case of recurrent mastoiditis with involvement of the labyrinth, which finally necessitated operation on the labyrinth.

In the treatment of the recurrence, the writer wishes to inveigh against the fixed practice of incision and drainage as the only mode of therapy. In many cases this will suffice to bring a cure, but every now and then the operator will encounter a case that continues to run temperature, refuses to heal promptly, or develops complications. These are cases which have either infected cells that need curettement or infected bone that requires removal, which Nature has laid down to fill in the bony defect of the previous operation. It should, therefore, be a routine procedure to explore every case with the idea of determining how much pathology is present.

As a prophylactic measure against future recurrences, one should at the original operation do a thorough exenteration of all infected material. While I do not subscribe to the belief that the so-called incomplete operation is the cause, or even the principal cause, of recurrences, I do not wish to be misunderstood as favoring incomplete surgery in the treatment of the acute mastoid. One should, likewise, take pains to pre-

serve the periosteum, which plays such an important role in the repair of the wound; and also not remove mucous membrane from the opening of the antrum and the aditus ad antrum. Hypertrophied and diseased adenoids, if possible, should be removed at the time of operation; and chronic running ears, which fail to respond to conservative treatment, may need a radical operation at the time of recurrence instead of the simple. The general condition of the patient must not be overlooked. Children should be put on a diet which will build up resistance against infection, the latter, after all, being directly responsible for the recurrence.

When an otitis media develops in a patient previously operated on, treatment must be prompt. It is a mistake to advise one's patient against drainage from the middle ear because bulging is not present. This counsel may be prudent in an unoperated mastoid, but unwise in an impending recurrence. The use of suction, if done carefully, is helpful in keeping the ear clean; but, if employed too vigorously will suck in infection from the nasopharynx and keep up a reinfection of the middle ear.

RESUME.

1. An operated mastoid heals by connective tissue, new cell formation, and bone regeneration, any one of which may predominate.
2. It is incorrect to contend that recurrences are usually due to previous incomplete surgery.
3. Rather, an acute infection, which gains access to the middle ear is the direct etiologic factor.
4. Predisposing agents include mastoid susceptibility, lowered general resistance, adjacent foci of infection, and faulty operative technique.
5. Treatment should include early myringotomy in impending recurrence; and when obliged to operate, one should thoroughly explore his field, taking care of infected areas as they present themselves.

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1505 Ocean Avenue.

ANATOMICAL AND CLINICAL COURSE IN OTOLARYNGOLOGY.

Indiana University School of Medicine announces a two weeks intensive anatomical and clinical course in otolaryngology, April 16 to 28, inclusive, 1934, by Dr. John F. Barnhill and members of the Staff, at the Medical School building, 1040 W. Michigan street, Indianapolis, Ind. Applications should be addressed to the Indiana University School of Medicine, Post-Graduate Department, Indianapolis, Ind.

REPORT OF TWO CASES OF NEOPLASM IN THE
EXTERNAL AUDITORY CANAL.
OPERATION, RECOVERY.*

DR. HUGH B. BLACKWELL, New York.

Case 1: Mrs. M. B., age 37 years, was admitted to the New York Eye and Ear Infirmary, February 3, 1932, with the following history: About a year previously she had noticed a slight discharge from her right ear. On attempting to clean the canal bleeding would sometimes occur, there was a progressive increase in the discharge and bleeding. Some three weeks before admission she came to the Clinic for the first time. On that occasion I observed immediately internal to the meatus a small fleshy looking growth apparently attached to the posterior wall. This was removed under local anesthesia and sent to the laboratory for examination; following its removal there was free bleeding at the point of its attachment. The membrana tympanae was apparently normal.

Dr. Samuels, our pathologist, reported as follows: Tissue is very fragmentary. It consists of granulation tissue in general, but at one point there is also some lymphoid tissue. One fragment shows scattered through the granulation numerous strands of epithelial cells. These cells show no tendency to pearl formation. They differ greatly in size, shape and staining reaction and are very suggestive of malignancy.

Diagnosis: Epithelioma?

We were requested to keep the patient under observation. The growth almost immediately returned and by three weeks after its removal entirely filled the canal and became twice the size of the original growth, apparently very vascular and bleeding freely at the slightest provocation.

The patient was admitted for removal of the growth under general anesthesia on Feb. 3, 1932.

*Presented before New York Academy of Medicine, Section on Otolaryngology, May 17, 1933.

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A curvilinear incision was made over the mastoid, the auricle and posterior membranous canal were retracted forward, exposing the posterior bony canal wall, which lay immediately beneath the apparent attachment in the posterior membranous canal and which had produced an erosion in the bony cortex at that point through which a probe could be passed. Feeling sure that the bone was the site of the tumor, I accordingly went ahead and performed a very thorough simple mastoid operation and in addition lowered the posterior bony canal wall as in a modified radical. With the exception of the erosion in the bone at the site of the tumor, the entire mastoid seemed normal, there were no granulations or pus and the cells were filled with air.



The tumor was removed from the canal and the membranous tissue of the posterior canal wall almost entirely exenterated.

At the conclusion of the operation the posterior incision was united throughout and the mastoid wound dressed per canal as in a modified radical. During convalescence, which was uninterrupted, the patient received two radium treatments.

The tumor removed was sent to the laboratory and Dr. Samuels' report was as follows:

There are nests of round cells stained deeply and areas in which the cells are paler and larger, approaching the squamous type, with a tendency to pearl formation. The growth

is composed therefore of a mixed type of cells—basal and prickle cells.

Diagnosis: Basal and prickle cell carcinoma.

This patient has been under observation for the past fifteen months; there have been no signs of recurrence, and she has gained thirty pounds in weight.

Case 2: Adult male, J. S., age 40 years, was admitted to the New York Eye and Ear Infirmary for operation Nov. 9, 1932, with the following history: Patient has had a purulent and at times bloody discharge from left ear for past twelve years. Three weeks ago he noticed for the first time a growth in the meatus of his ear and three days ago, on arising in the morning, he found his bedclothes stained with blood and immediately came to the Clinic.

At that time there was observed a large tense black tumor apparently covered with epithelium, which filled the concha, presumably attached by a pedicle arising somewhere in the region of the middle ear or mastoid.

Operation: The usual curved incision was made behind the left ear and the mastoid exposed. The bone was sclerotic, containing no cells except in the region of the antrum, which was opened and found to be filled with foul cholesteatomous material.

The posterior bony canal wall was lowered and the epitympanic ring removed in its superior portion. Before attempting to remove the growth the usual radical flap was cut and most of the bone work incidental to a radical was concluded, as I was desirous of observing the source of attachment of the tumor. I was unable to accomplish this with accuracy, as its narrow pedicle was accidentally separated from its base during these maneuvers. I believe, however, it sprang from the region of the Eustachian tube. The tumor was removed and sent to the laboratory for section and examination. Dr. Samuels' report is as follows:

Tumor from the external auditory canal. The center of the tissue is composed of hemorrhage which has not undergone organization, while in the periphery organization of the clot is taking place and fibrous tissue is being formed. Here the tissues are infiltrated with round cells and fibroblasts are noted. Canalization of the clot is taking place throughout.

Diagnosis: Organized blood clot.

In conclusion I would emphasize the importance of careful microscopic examination of all suspicious looking growths removed from the auricle or external auditory canal, no matter how insignificant in size the specimen may be. The value of following this procedure was clearly shown in the final results obtained in the first case. Secondly, I feel that the use of radium is valuable after the operation.

114 East 54th Street.

POST-GRADUATE COURSE IN OTOLARYNGOLOGY.

The Washington University School of Medicine, of St. Louis, offers an intensive four weeks' course in otolaryngology. The course begins June 18, 1934. It is desired that only qualified practitioners in otolaryngology apply for admission. The purpose of this course is to bring to the attention of the group the more recent advances in otolaryngology. Particular attention will be given to the basic sciences connected with the specialty. The physics, the pathology, the anatomy, the physiology, the embryology, the bacteriology and the cytology will be studied. The influence of nutrition and atmospheric conditions upon the sinuses will be considered. The work in these sciences will be given in the laboratories of the Oscar Johnson Institute.

The clinical work will consist mainly of a study of the relationship between diseases of the ear, nose and throat and systemic disease. Otolaryngologic diagnoses, including endoscopic, will be stressed in clinical conferences and on ward walks. Most of the operative work will be given in the anatomical laboratory. There will be clinical and laboratory demonstrations of allergy of the nose and sinuses. Attention will be given to the care of the deaf child and to speech defects.

A limited number of otolaryngologists who desire to specialize further along particular lines in otolaryngology are, on completion of this regular graduate course, permitted to continue with special work if arrangements are made with the member of the faculty in charge of the particular branch of otolaryngology in which they are interested.

For information, write to Dr. L. W. Dean, School of Medicine, Washington University, St. Louis.

ACUTE MASTOIDITIS, COMPLICATED WITH SEPTIC
LEUCOPENIA AND LOCAL LESIONS OF THE LIPS,
NASAL ORIFICES AND PHARYNX, RESEMBLING
THOSE OF AGRANULOCYTOSIS. REPORT
OF A CASE.*

DR. ARTHUR J. HERZIG, New York.

Patient, female nurse, in late thirties.

Past History: Age four, diphtheria; at eight, varicella; typhoid during 1917. In latter part of 1931, treated her for recurrent head colds, to which she has been subject for the past number of years. During February, 1932, I treated patient for adenitis of the infra thyroid lymph glands, which were enlarged and painful. At this time there was also a large amount of post-nasal secretion, which came from right antrum. Antrum was syringed by me through natural ostium until well. (Infected.)

Dec. 8, 1932: Developed a left acute purulent otitis media, which I incised under local anesthesia. Patient admitted to hospital Dec. 9, 1932, at 1 A. M. Suffered with severe mastoid pain. Temperature upon admission 103.4° , pulse 114, respiration 36. Ear draining.

Dec. 10: Condition unchanged.

Dec. 11: Ulcerations, such as are seen in agranulocytic angina, inside of both nostrils, aural discharge profuse and straw colored. Smear showed short chain streptococci. No sagging of posterior wall seen.

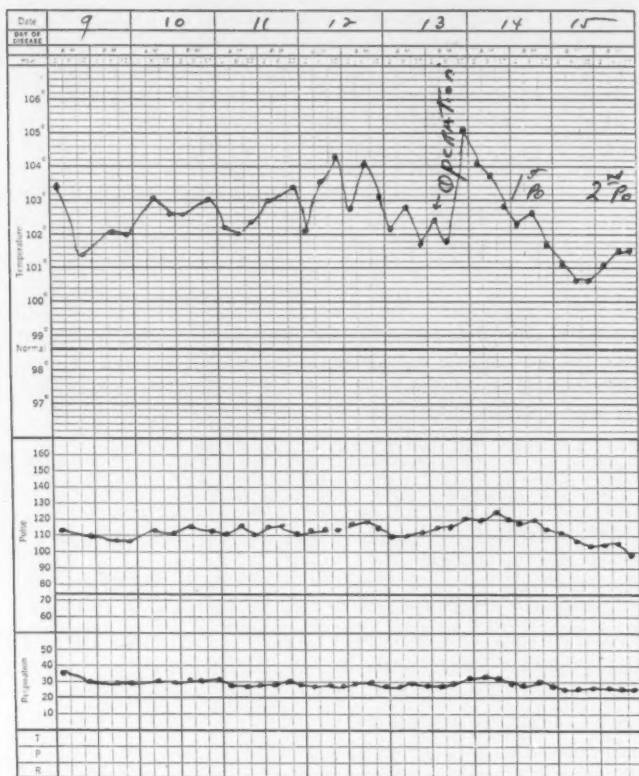
Dec. 12: Condition unchanged. Blood picture showed leukocytes 3,200, polys 9 per cent, basoph. 1 per cent, monos. 4 per cent, large lymph. 12 per cent, small lymph. 55 per cent, metamyelocyt. 19 per cent.

X-ray showed left mastoid process to be irregularly clouded throughout and seat of a subacute infection. The cells seem

*Presented before New York Academy of Medicine, Section on Otolaryngology, May 17, 1933.

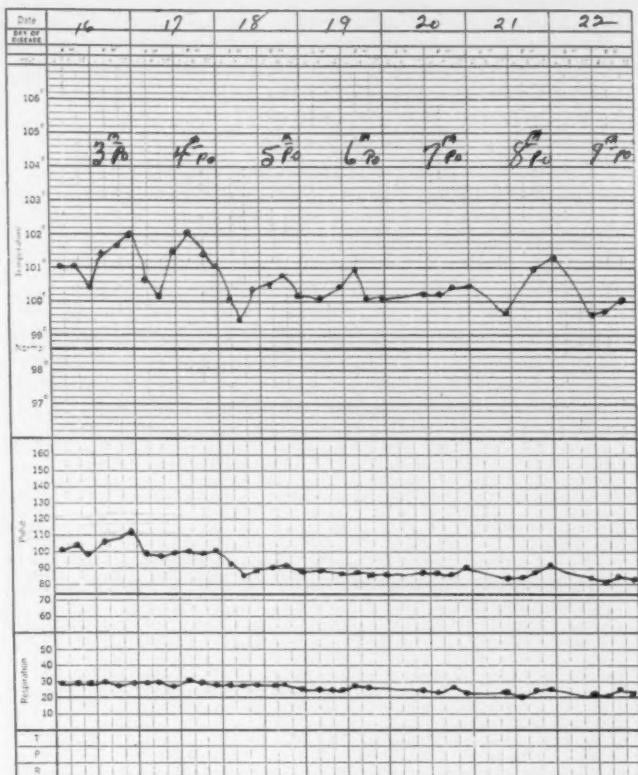
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markedly thickened and their appearance showed coalescence of the cells. The cells appear partially pneumatic and those more anterior and adjoining the antrum irregularly opaque and contain granulations or exudate.



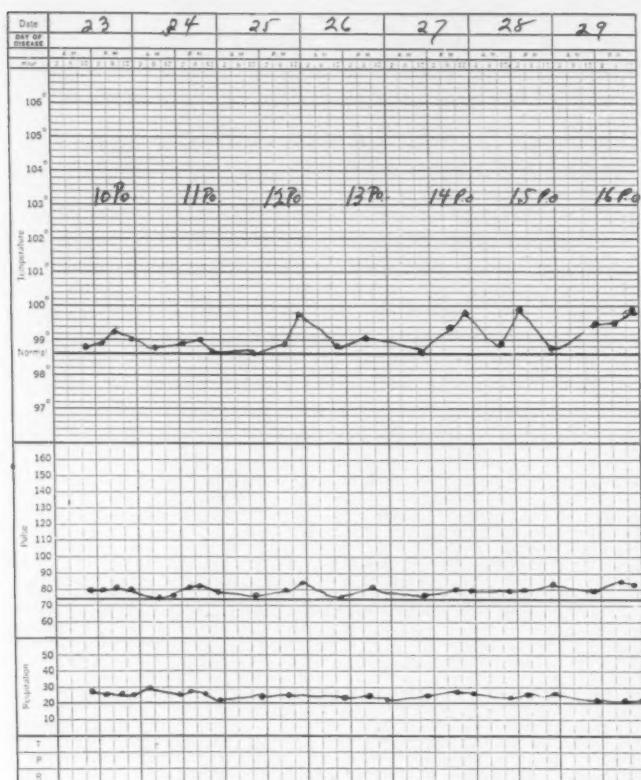
Dec. 13: Temperature 101.8°, pulse 110, respiration 28. Small ulcerations were present on the pillars of the fauces, and also on the lip margins, where the lips touch, and in each naris. Blood Count: leukocytes 1000, polys 8 per cent, basoph. 1 per cent, monos. 8 per cent, large lymphocytes 13 per cent, small lymphs. 47 per cent and metamyelocyt. 21 per cent. Transitionals 3 per cent.

Operation at 2:30 P. M. At 1:00 P. M., patient received 1/6 gr. morphine, with 1-200 atroph. sulph. Avertin anesthesia administered. The usual Curvilinear incision was made one-half inch posterior to the auricle; very little bleeding occurred. The integument was not infiltrated nor edemata encoun-



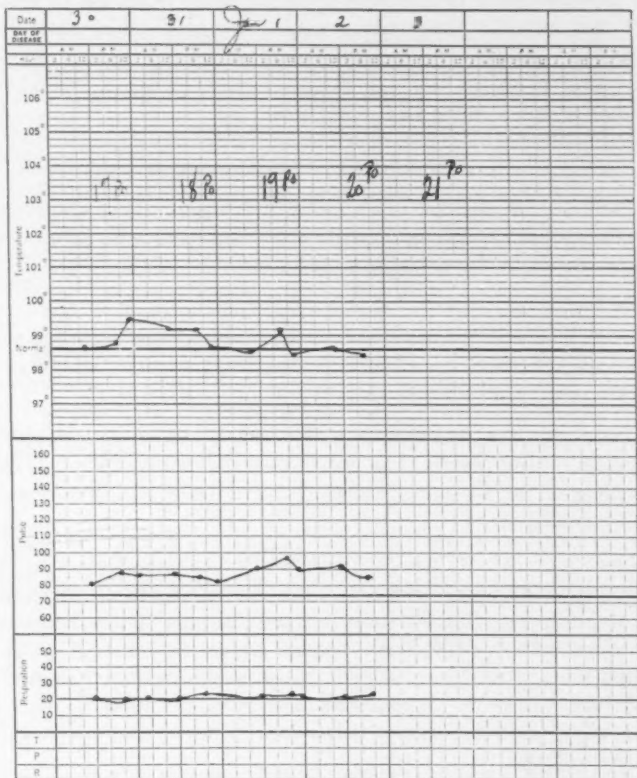
tered but was markedly thickened. Periosteum incised and found adherent throughout. After separating same and freeing tip of mastoid, the mastoid process was uncapped, and the bone was found sclerotic in the upper two-thirds. At the first uncapping grayish exudate under pressure, with granulations presented. A culture was taken of the secretion and

a piece of the necrotic bone, as well as membrane, given for path. examination. A large pneumatic mastoid with broken down cells at the tip (which had coalesced) and the entrance of the mastoid antrum were carefully curetted away. Tip removed with a large Ronguer. Infected and necrotic anterior



and posterior zygomatic cells curetted. One small cell above the lateral sinus wall curetted. After thorough exenteration of all diseased tissue the wound was lightly packed with iodoform gauze, the periosteum brought together with two catgut sutures, leaving a small drain at the lowest angle of the wound (*this approximation of the periosteum has been per-*

formed by me for the past 23 years and results in hardly any depression in the healed mastoid wound). The skin wound was closed with Michel clips. The external wound was then painted with a 1-200 acri-violet solution. The usual mastoid dressing applied. Duration of operation, 35 minutes. Anes-



thesia ideal. No drain was placed in external auditory canal, which was so thickened (similar to skin over mastoid) as previously described.

Observation at the Operation: No granulations were present around the mastoid antrum, although necrotic bone was present. No extreme breaking down of all cells was present.

The sclerosis of the cortex with the complete necrosis of all cells anterior to the lateral sinus wall. Hardly any bleeding was noted; only one ligature was used. No bleeding from the mastoid cavity was noted. Patient in good condition throughout the operation. It was noticed prior to operation that there was a marked swelling over the parotid gland area. This was of an edematous nature and probably came from the infection of the anterior zygomatic cells. A small ulceration had appeared on the right anterior pillar of the fauces on the morning prior to the operation. Patient reacted well, temperature 105°, pulse 122, respiration 28.

DIFFERENTIAL COUNT CHART.

Dec. 13. *Report of examination of tissue:* Bone tissue No. 3043. Gross: Specimen consists of a small fragment of bone removed from the mastoid region.

Microscopic: Section shows increased porosity of the bony tissue with a fibrinous exudate attached to the external surface of the bone, containing a moderate number of polynuclear, plasma and small round cells.

Dec. 14: Temperature 8 A. M. 102.4°, pulse 112, respiration 26. Leukocytes rose to 7000 with polys. 37 per cent, whereas prior to operation they were 1000 and 8 per cent respectively.

Dec. 15: A. M. temperature 100.4°. Leukocytes rose to 7800, with polys 45 per cent. Patient comfortable. Mastoid wound dressed. Small amount of pent up pus found over ear; all clips removed to drain same. Drain in mastoid wound found dry; replaced acri-violet drain in external ear, as swelling had markedly diminished and same applied to throat and nasal orifices, every three hours, now absolutely free of ulcerations.

Dec. 16: Patient irritable. Readily exhausted. W.B.C. 7800, polys., 60 per cent.

Dec. 17 and Dec. 19: Very large amount of secretion in wound. Acri-violet 1-200 used, saturating iod. gauze packing in canal of ear. Dec. 19: Leukocytes 8000, polys., 65 per cent.

Dec. 20: Wound dressed.

Dec. 22: Markedly diminished secretion. Poly count dropped to 48 per cent, with 4600 leukocytes. Patient's temperature nearly normal. General condition good.

Jan. 3, 1933: Left hospital this A. M.

Jan. 14: Mastoid wound granulating nicely. Patient feels much stronger.

Jan. 27: Ear completely dry. Small perforation present in lower half of ear drum, posterior to tip of malleus. Mastoid wound granulating nicely.

Feb. 6: Leukocytes 6600, polys. 60 per cent, basoph. 1 per cent, lymph. (large) 8 per cent, lymph. (small) 31 per cent. No abnormal cells seen; few anemic R.B.C.

Patient was given deep gluteal injections (K96) twice daily, starting Dec. 16 and ending with one injection Dec. 20, 1932.

Conclusions: Any case of mastoiditis, presenting itself with a toxic leucopenia, should be operated upon at once. It is inadvisable to build the patient's resistance up first in this type of case.

667 Madison Avenue.

SURGERY AND DIETETIC TREATMENT IN ITS RELATION TO NASAL PATHOLOGY.

DR. E. V. ULLMANN, Portland, Ore.

Until a year or two ago it was an accepted fact that surgery was the predominating procedure in patients with sinus trouble. Recently the attitude has changed so radically that one reads and hears of wholesale condemnation of surgery. Extremes never last. The error which occurs in such opinions comes about because a conception of sinus trouble had been accepted by physicians as well as laity without consciousness of the fact that the term "sinus trouble" does not refer to a particular disease, but only to the location of a disease. As in every organ in the human body, we here also have to deal with a multitude of diseases if trouble occurs. The exact diagnosis has to be left to the specialists, who, on their part, cannot and often do not explain the exact pathology, particularly so as the term "sinus trouble" seems to satisfy the patient as well as the family physician. There is a certain group of sinus diseases which have and always will have to be subjected to surgery if a cure is to be obtained. The greater number of patients, however, do not have to submit to surgery, but can be treated with much better results by dietetic treatment. In my previous writings about diet in sinus infections it has not been made clear which of the various pathologic conditions of the nose and the sinuses should primarily be taken care of with surgical methods and which should be subjected to medical treatment. There is no such classification yet in literature. Therefore, we find much confusion in the discussions of this problem.

Table 1: The following table gives a classification of the nasal pathology that has been generally grouped under sinus trouble. On the right side we see four conditions in which surgery should be considered at once. Unilocular sinus suppurations should be operated upon if properly diagnosed, in order to prevent spreading and the establishment

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of a focus for infection. Acute empyema of two or more sinuses will require operation if they do not disappear within one or two weeks for the above mentioned reasons. For complications of eye and brain, the necessity for surgery is beyond discussion. Hypertrophy of the turbinates, particularly if nasal breathing is impaired, requires surgery.

TABLE I—SINUS TROUBLE.

MEDICAL TREATMENT PRIMARILY.	SURGERY PRIMARILY.
Pansinusitis chronica suppurativa.	Every unilocular sinus suppuration.
Rhinopharyngitis chronica.	Acute empyema of two or more sinuses.
Rhinitis congestiva with headache.	Complications involving eye and brain.
Rhinitis vasomotoria.	Rhinitis hypertrophica.
Recurrent coryza.	
Dry deafness in its various forms as far as influenced by nasal irritations.	
Allergic Polyps.	
OZENA.	

On the left side of the table we find the larger group of the so-called sinus troubles in which a general and particular dietetic treatment must be placed in the foreground. Chronic pansinusitis gives the impression of a constitutionally conditioned disease in which repeated operations have so far failed in leading to an improvement or cure. The majority of patients with chronic pansinusitis whom I have seen had been operated upon from two to twenty-five times. In chronic rhinopharyngitis, prevalent in old people, surgery should not be attempted because the condition yields very favorably to local treatment combined with diet.* Congested rhinitis with headache seems to be closely related, if not identical, with Sluder's nasal syndrome, for which Sluder advised the treatment of the sphenopalatine ganglion region. My experiences in the last two years, however, indicate that better results may be obtained by dietetic treatment because the patient is emancipated from the doctor's office and learns how to take care of himself by diet only. In a few cases a combined treatment has been necessary. Vasomotor rhinitis has been accepted for years as a poor object for surgery and the majority of cases yield to proper dietetic care. Both of these latter forms of rhinitis occur most frequently in women between the age of 16 and 45.

*In occasional cases a rhinopharyngitis is caused by suppuration from one or more sinus cells. These cases cannot be operated.

Recurrent coryza seems to give most favorable results with dietetic treatment. This group contains patients who complain of frequent and repeated colds during one season, but if held properly on the diet, go through the year free of colds. Finally cases of so-called dry deafness are closely related to the previous group, but the patient comes to the office primarily because of increasing deafness. In my practice, none of these cases showed symptoms of suppuration in the middle ear and all could be classified as tubotympanic catarrh, chronic adhesive processes, otosclerosis and such forms of deafness as can be called dry. The last two groups with allergic polyps and ozena have been placed in the middle of the table because a definite attitude as to surgery cannot be taken in advance. The procedure must be decided individually in every case. Dietetic treatment, however, has proven to be of benefit in every such case, independent of whether surgery was done or not.

TABLE II.

SINUS PATIENTS (from past 15 months).....	170	
Surgical:		
Unilocular sinus suppuration.....	10	
Acute empyema of two or more sinuses.....	2	
Complications from eyes or brain.....	6	
Rhinitis hypertrophica.....	6	
Total	24=14%	
Medical:		
Pansinusitis chronica suppurativa.....	16	Combined treat: (2)
Rhinopharyngitis chronica.....	9	
Rhinitis congestiva with headache.....	20	(1)
Rhinitis vasomotoria.....	15	
Recurrent coryza.....	56	(4)
Deafness.....	30	(3)
Total	146=86%	Total (10)=6%

Table 2 shows the number of cases in which surgery was necessary. From a total of 170 cases observed in the past 15 months, only 24 (14 per cent) were such that surgery was at once considered. The results justified the method because all but one were cured, this one dying of meningitis. All the other 146 (86 per cent) were treated by dietetic therapy. In 10 of these it was necessary, during the course of the treatment, to perform minor nasal operations, such as submucous resection, turbinectomy for hypertrophy, severing adhesions and twice a window operation for the maxillary antrum.

So far the time has been too short to give definite statistical data as to the results of the treatment, but one point is certain. The results are far more favorable and satisfactory than before I applied the diet in the same type of patients. An examination of over 100 of these patients half a year after the onset of the dietetic treatment showed definite improvement or cure.

The latest statistical report of similar type that I could find in literature is that of Lyman Richards, who reports the results of 500 sinus cases treated in the Children's Hospital in Boston up to the year 1931 (see Table 3). He does not classify the various forms of pathology as I have done, as stated in the above table. According to his report, 46 per cent of the total were submitted to surgery and 46 per cent

TABLE III.

Table of Lyman Richards reporting on 500 sinus cases from the Children's Hospital in Boston.			
Surgical Treatment.....	46%	of Total	
Medical Treatment.....	54%	of Total	
Type of Treatment	Cured	Improved	Unimproved
Medical	44%	17%	39%
Surgical	34%	20%	46%

of these were unimproved; 54 per cent of the total were treated medically. In comparison, in my series, 14 per cent were treated surgically (all cured but one, who died of meningitis) to 80 per cent treated medically, with six per cent treated by combined methods. This comparison seems to demonstrate clearly the change of opinion in the attitude towards sinus diseases, and the reason for it. There is naturally a certain difference in the material of Richards' statistics and mine, as his cases were mostly children up to the age of 16, and the majority of mine were adults, with only 17 children out of 170, i.e., ten per cent; and secondly his report apparently ended at the beginning of 1931, while I began my report in the beginning of 1932. For this reason precisely a comparison seemed to be interesting because the years of 1930 and 1931 seemed to be the time when a radical change of opinion took place.

Of what does the dietetic treatment consist? Two factors must be considered as common to the vast majority, if not to all of these cases which I have included on the left side of

the table. First, they all show a very pronounced acidotic condition with a tendency to headache, constipation, heartburn, free perspiration with offensive odor, bad breath, inclination to irritations of the skin and they all show a very acid urine with a Ph of 5.8 to 4.6. Secondly, all of these patients must be considered as suffering from a calcium deficiency. Long before the clinic of sinus diseases had been developed, calcium drugs in various forms had been advised in all countries. If one treats such patients medically with these two factors, acidosis and calcium deficiency, in mind, one has an instrument in hand to combat these conditions far more effectively than by planless and unjustified surgical procedures.

The first point to be considered, the acidotic tendency, can be counteracted effectively by giving a base forming diet with restriction of starches and meat and a prevalence of lacto-vegetable food. In order to prevent an eventual lack of vitamins, fresh and unprocessed food in all its varieties must be given. This advice given to patients alone, however, will not lead to success because of the inability of most people to prepare food, particularly vegetables, in such a way that the minerals are not lost. It cannot be the object of this paper to describe the application of the dietetic treatment in detail and I have to refer in this respect to my book, "Diet in Sinus Infections and Colds," published recently by the MacMillan Company, New York.

The second point to be considered and the one which I will discuss more in detail, is the calcium deficiency. As far back as 1911, Sherman called attention to the calcium deficiency of the average American diet. It seems surprising that in spite of Sherman's, McCollum's, Barborka's studies and the many other investigations on calcium, such a calcium deficiency still exists. Yet the prevailing opinion still is that bread is the staff of life and that the ordinary mixed meal represents a sufficient diet.

It seems now to be accepted that 0.45 gm. of calcium fills the actual daily requirement for an adult person, but this represents the minimum of the actual need rather than the normal allowance. Sherman and others estimate the optimum allowance of calcium to be around 0.70 gm., equivalent to 1.0 gm. calcium oxide. Most of the facts on which such figures are based can be traced back to experiments on rats and other animals fed on low calcium diets as compared with animals

fed on high calcium diets. The conclusions are made from the growth, the duration of life and the fecundity of the animals. Sherman repeatedly gives expression to his opinion that a number of weaknesses, the susceptibility to infections and inflammations, as well as the many run-down conditions, may be the result of a calcium deficiency. R. Bernheim, of New York, recently reported in the *Journal American Medical Association* on an investigation of the dietary histories of more than 4,000 unselected patients from various New York hospitals. This report reveals the surprising fact that only two of the 4,000 patients had a diet adequate in calcium; both of these were in the hospital because of an accident and

TABLE IV.

Table of Alice R. Bernheim, M.D., based upon an inquiry of 4000 unselected cases in the New York hospitals, revealing that only 2 out of the 4000 showed a diet adequate in calcium (0.70 gm. of calcium per day.) A low calcium diet shows a continuous negative calcium balance.	
Calcium intake.....	300 mg. (approximately)
Calcium output.....	790 mg.
Feces	600 mg.
Urine	190 mg.
Negative balance.....	490 mg.

not because of a disease. The same author concludes in one of her tables that the average patient examined showed a calcium intake of 300 mg. per day, a calcium output through feces, 600 mg. per day; through urine, 190 mg.; making a total calcium output of 790 mg. per day, leaving the patient with a negative calcium balance of 490 mg. per day. Whether these figures are general is hard to state unless mass experiments were carried out. But such figures are important enough to call every physician's attention to this problem.

It is an amazing fact that with all interest concentrated on the calcium problem, one of the most important factors of this problem seems to be overlooked and neglected in American literature. This is the relation of calcium to the other anions, such as sodium, magnesium and potassium. Ever since Luithlen, in 1912, called attention to the relationship of the anions to each other is this factor gaining importance in European research. The retention, assimilation and elimination of calcium is greatly dependent on the intake of sodium. While all anions, that is basic metals, are taken in as far as contained in the food only, sodium is the only one taken in by

the average person in very large amounts, much larger than the body requirements. The amount of salt daily consumed of which sodium is the most important constituent, are from five to eight times more than the body requirements. The main characteristic contributed to salt, so far, is its water retaining power. One part of sodium retains 70 parts water in the tissues. A person weighing 150 pounds can retain about 4 litres of water, equal to 1 gallon, without showing edema. This point is undoubtedly of the utmost importance in the treatment of all inflammatory and congested conditions of mucous membranes. Not only can we prove this in experiments but we have many clinical evidences for this fact. Every acute congested condition, with which we always have to deal in acute as well as chronic sinus diseases, will react markedly if by restricting the intake of sodium chloride the dehydrating component of this measure is brought to the maximum. In other words, the stricter the salt restriction in acute infections and swellings, the better the result. For less acute and chronic cases the restriction of sodium chloride will not be as effective by its dehydrating power alone but will act through the relation of sodium to calcium. Several years ago I worked on this problem with H. Eppinger, studying the effects of a calcium-poor diet in normal and sick people during post-war times in Central Europe. The experiments consisted of examining the calcium and magnesium elimination in feces and urine after a period of four days, during which a diet used in those days, plus 5 gm. sodium chloride, was given. During the following two days the amount of sodium chloride was raised to 30 gm. per day. The following four days, the same food and 5 gm. sodium chloride was given. The examinations were made in periods of 48 hours. We found that a normal person eliminated during and after the increased sodium intake approximately 6 per cent more calcium and 7 per cent more magnesium than during the time of the lower intake of sodium chloride. We examined patients with chronic rheumatism, frequent colds and chronic tonsillitis, and found the calcium elimination during and after the increased sodium intake period raised to 26 per cent more than before. We also found that patients with diseases affecting the skeleton, such as osteoporosis and osteomalacia, eliminated in the same type of experiment 80 per cent or more of calcium. We made similar experiments using, instead of sodium chloride, sodium bicarbonate. While the amount of eliminated calcium varied

slightly as to the percentage, the fact remained that during and after the increased intake of sodium, the amount of eliminated calcium was multiplied.

It seems, therefore, that we can conclude that not the molecule sodium chloride, but rather the atom sodium plays the important role in calcium metabolism. From these experiments as well as from the research of many others it must be concluded that the assimilation of calcium is greatly handicapped if large amounts of sodium are taken. The relation of the anions, one to another, depends on their valency. Magnesium and calcium are bivalent elements, while sodium and potassium are monovalent elements. Therefrom, it can be concluded that it takes 2 molecules of sodium, respectively potassium, in order to expel 1 molecule of calcium or magnesium. In other words, the mutual action of the anions, one upon another, always remains equivalently balanced. If we presume, based again upon experimental work, that a certain amount of assimilated calcium in the organism is necessary to prevent infections and inflammations, it can clearly be seen that this physiological relation of calcium, which is comparatively scarce in our food, to the sodium, which is abundantly taken without food, must be watched closely if we do not want to lose too much assimilated calcium.

Let us now return to Sherman and the many other authors who have made studies on the influence of calcium on rats and other experimental animals. They all agree as to the calcium minimum, optimum and maximum in the diet taken from experiments fundamentally different from human nutrition. Most of these experiments are carried out with extreme diets, either calcium poor or calcium rich. Many of them containing only one food on which the animal lives exclusively during the time of the experiment. The type of these experimental diets is given in the many reports by Sherman and other investigators, and is described in a very recent interesting paper on the prevention of dental caries by M. Caldwell Agnew, R. Gorden Agnew and F. F. Tisdall from the University of Toronto. A diet with a calcium content of 1 per cent is considered in most of these animal experiments as a calcium poor diet, with $1\frac{1}{2}$ to 2 per cent as a calcium rich diet. In most of these experiments the content of sodium chloride was within 1 to 2 per cent. We can therefore see that the

relationship between calcium and sodium chloride ranges from 1:1 in calcium poor diets, to 1:2 or 1:2½ in calcium rich diets. In contrast to this let us look to the human nutrition. It has been pointed out that the calcium needs are best met if approximately 1.0 gm. of calcium oxide is taken and it has also been shown that these needs are met only by a negligibly small amount of people. If we neglect the sodium content in natural food altogether, which even in salt poor and so-called salt free diets ranges around 3 gm. per day, and we consider only the amount of salt taken voluntarily in the form of added table salt, we come to a figure which ranges between 8 gm. in moderate salt eaters to 25 gm. in excessive salt eaters. This amount is taken by the organism in excess to the salt contained in natural food. Hence the relationship between calcium and sodium chloride in human food varies from 1:8 to 1:25. This must be considered enormous in comparison to the animal experiments.

If, therefore, Sherman and the many others accept 1.0 gm. calcium oxide as the daily need for the human organism, they accept that amount based upon experiments which do not include large enough intakes of sodium chloride in order to compare the experimental animal diet with that of the human nutrition. Because it is not easy and probably in the majority of cases impossible to increase the calcium intake over a long period of time above the 1.0 gm. of calcium oxide per day, we should pay more attention to the restriction of sodium chloride wherever we feel that the organism lacks the effects of calcium.

Here, in my opinion, lies the shortcoming of every calcium therapy. von Noorden emphasized, time after time, in his many writings that no application of calcium can be expected to be successful, whether given internally, intramuscularly or intravenously, unless the mineral metabolism, particularly that of sodium chloride, is closely watched. He repeatedly called attention to the paramount importance of restricting salt wherever there seemed to be a calcium deficiency in the organism.

As to the application and details of the dietary treatment I have to refer to my above mentioned book, as this cannot be the subject of this paper.

CASE REPORTS.

Case 1: Miss J. R., age 16 years. Complains of frequent colds during the entire year, gains weight rapidly, extremely pale and pasty, fatigued, headaches. Muco-purulent discharge from all sinuses. One year ago a bilateral window operation of the maxillary antrum was performed with no relief. Urine Ph. 5.6, Nacl 13 gm., eos. 3.5 per cent. The girl was put on a diet with no local treatment except an ephedrine spray and high doses of calcium. She rapidly improved and has been 7 months free of colds. A recent examination showed no congestion in mucous membranes of the nose and some muco-pus on the floor of the left side. She showed color in her face, less anemia, has no headaches and feels very well.

Case 2: Mrs. R. B. E., age 28 years. Came to the office with the typical complaints of vasomotoric rhinitis. One side of the nose always closed for breathing and sometimes both sides, bad breath, profuse perspiration with aggressive odor; claims she has to be careful during menstruation on account of the odor, fatigue. Took several times treatments from specialists consisting of intranasal applications of drugs. Urine Ph. 4.2, Nacl 14 gm., eos. 1 per cent. She also noticed that her conditions were worse when she ate in restaurants. After being on the diet for 5 months, no complaints. The improvement became manifest as soon as 3 days after the diet was started.

Case 3: Mr. M. C., age 45 years. Complains of excruciating headaches whenever his nose becomes congested. Being a lawyer, it is sometimes impossible for him to proceed in court, as his severe headaches make clear thinking impossible. When I first saw him I gave him a treatment to his sphenoid ganglion district, as Sluder described years ago, which seemed to relieve him within one-half to one hour. But we soon found that this relief was only temporary. After trying this treatment several times the patient asked as to whether he would have to come indefinitely for treatment, because the treatment only relieved his pain for a day or two. On examining his urine I found it very acid, with a Ph. of 5.2 and extremely high chlorides, Nacl 20 gms. As soon as he was put on a salt poor, basic diet he reported that he was relieved of his headache, which returned only after he attended a banquet or ate highly salted food. I saw him recently after being about 14

months on the diet and he reassured me how much my advice had helped him and that he was very careful in avoiding the "nuisance" as he calls it.

Case 4: Mrs. A. B., age 68 years. Complains of severe headache, drawing in the nose, purulent discharge from the nose for several years. She also suffered from a tubo-tympanic catarrh which could be relieved temporarily by catheterizing. In examining the nose one could see the results of the 9 previous, more or less radical, sinus operations which had been performed on practically all sinuses. Neither the discharge nor the other complaints had been improved by these operations and the patient on the contrary went from bad to worse. When I first saw her she came with the expectation of undergoing once more one of the dreaded operations. A complete examination revealed that this woman suffered from an advanced arteriosclerosis, very probably of the big vessels, with low blood pressure. All dietetic experiments and internal treatments in collaboration with an internist failed to bring any improvement. Even the most carefully carried out basic diet would not increase the urine Ph., which was always around 5. It also was evident that a local treatment with operations on the sinuses could never be successful in a case in which the fundamental functions of the respiratory and digestive organs are severely disturbed. Such a case must be considered as incurable.

Case 5: R. O., age 6 years. Extremely nervous, very pale, pasty skin, asthma at the age of 2, frequently hives, severely impaired nasal breathing. Tonsils and adenoids previously removed. Examination revealed a highly congested condition of all mucous membranes of the nose with a pedunculated polyp on the right side. Considerable mucous on both sides. Urine Ph. 6.4, Nacl 8.5 gm., eos. cells 6 per cent. The mother says that the child gets hives after eating strawberries, rhubarb and some vegetables. Considering the rather alkaline urine, the high percentage of eosinophil cells and the history, a food test was made showing that the child reacted against many vegetables and starches, but not to proteins. His diet was regulated accordingly, with a prevalence of meats, milk, few and selected starches and selected vegetables and fruits. Before the diet was started the polyp in the right side of the nose which caused an accessory irritation, was removed. The child made a remarkable and surprisingly fast recovery in

that he was free of complaints and very much less nervous after being on the diet with all salt removed for not more than 10 days. I tried to test the tolerance for salt and found that he could take from 1 to 1.5 gm. of salt without showing any symptoms. Whenever this daily amount was over-stepped he showed difficulties in breathing and became nervous again. His salt elimination now is around 4 gm. per day, about half of what it was at the onset of the treatment.

Case 6: Mr. D. Sp., age 45 years. Complaints of frequent colds during most of his life with definite rheumatic complaints, slightly decreased hearing, which becomes worse after every cold. At the time of examination no evidence or pathology in the nose was found outside of scars due to 2 previous sinus operations. A submucous septum resection as well as a tonsillectomy also had previously been performed. Urine Ph. 5.4, NaCl 16 gm. No local treatment was given and the therapy consisted entirely of dietetic measures. The patient has been free of colds for the last 13 months and his rheumatism has disappeared entirely outside of occasional admonitions.

These case reports represent by no means a complete survey of the results, but should only demonstrate on a few characteristic cases the influence of the dietetic treatment.

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EXTERNAL ETHMOIDECTOMY.*

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Introduction and History: When one attempts a review of the literature available on the ethmoid and sphenoid sinuses, the impression is gained that there is a variance of opinion concerning the proper management of this condition. When there is such a variance in any department of medicine, it is conceded that the subject has not reached a high degree of perfection. The dangerous anatomical location and the absence of possible animal experimentation renders this particular "problem," as it has often been termed, less easy to attack and put on a finished basis. It is interesting to see the pendulum of popularity swing from conservatism to more radical views, then back and forth, depending on the influence of popular rhinologists and writers.

A second noteworthy fact gained from summing up the literature is the paucity of available material on the external ethmoid operation. In the past few years this operation has enjoyed a very partial attitude among some of the most competent rhinologists of the nation. That the procedure has not gained a more universal popularity, yet is very popular with a few quite successful men, is because there has been practically nothing written on it. Sewall¹ has written some excellent articles in which he has described special instruments, a special osteoplastic flap and a method of exposure of the optic foramen. We are at a loss to find in the literature good concise descriptions of the technical procedure or of results from the operation, yet when we correspond with men using it, we find hearty commendation of its virtues and results.

Sinus surgery needs to be put on a more definite and established basis. The many bad results which come from the widely practiced "puttering" operations destroys confidence in the minds of the public, the general practitioner and some specialists. People are slow to accept changes in medical or surgical procedures. To see results is the only convincing

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method to win anyone to a cause. The external operation is in its infancy because a degree of perfection was only recently established and because extensive publications and descriptions are wanting.

Because of these factors and because the external ethmoidectomy has met with satisfactory results in our hands, we are writing this paper. We hope to invite further discussion and comments from those acquainted with the operation. It is not our intention to belittle the intranasal operations, as we are fully cognizant of the value of the various methods. These have been well described by Fenton.² It is not within the scope of this paper to describe the surgical anatomy which is so well presented by Mosher.³ In brief, we shall attempt to describe the operative procedure, record a few noteworthy cases, review the history and note the result of seventy-five operations.

The European rhinologists were the foremost to invade the frontal and ethmoid cells by an external route. As early as 1750, Runge opened and obliterated the frontal sinus. The methods of Nebinger-Praun and Luc-Ogston are precursors in the development of frontal and ethmoid sinus surgery. The work of Kretschmann, published in 1917, was chiefly a review of the latter method. Hajek,⁴ between 1900 and 1917, had repeatedly opened the frontal sinus and from this cavity gained access to the anterior ethmoid cells, curetting them extensively. Lynch⁵ popularized the external frontal operation in the United States. A brief description only of this method is available. He used retractors of weighted catgut hanging over the eye which was covered and made the point clear that elevating the superior portion of the frontal periosteum interfered with nutrition and growth of the bone, which resulted in fistula and osteomyelitis. This was a decided step forward from the Killian frontal sinus operation. Cullom⁶ of South Carolina, reported on the results of one hundred external fronto-ethmoid operations. Mithoefer⁷ of Cincinnati, has had extensive experience with the external operation. He believes that in cases with prolonged headache, focal symptoms or asthma, the intranasal operation is inadequate and the external ethmoidectomy is indicated.

To Greenfield Sluder⁸ we are indebted for an abundance of information concerning the posterior group of sinuses. As

early as 1900 he described a series of frontal headaches, apparently of ocular origin, but really of nasal origin. He named and defined the syndrome of a neurosis of the sphenopalatine ganglion, calling attention to the physiological relationship to the nasal mucosa, its anatomical distribution, its variations and the direct and reflex manner in which it may produce pain and headache, both near and remote. He realized the importance of the sphenoid body, which was and still is neglected as a factor in nasal pathology. We now have direct methods of approach, viz., by the transantral route and the external ethmoidectomy, which renders the approach to the sphenoid far less hazardous and the relief of these conditions more frequently possible. We have been able to substantiate Sluder many times in his postulates advanced so early.

Ferris Smith⁹ has contributed much to sinus surgery. At his clinic at Grand Rapids, he has worked out a technic for the cure and relief of asthma in selected cases. To aid this purpose he has adopted the use of 5 per cent picric acid in 25 per cent acetone to remove every vestige of mucous membrane in case any may be left at the end of the operation. He also worked out the idea of using inverted split skin grafts which are placed around a rubber tube to line the nasal cavity and assist in repair of the surgical area. We have not used these, but believe they might be of advantage where expert and speedy assistance in preparing and placing the grafts will not retard an already prolonged operation. The retractor designed by Ferris Smith has been a great adjunct to the speed, exposure and facility of the operation. The problems of understanding the operative indications and the development of the surgical procedure are based on an immense effort and study by these famous rhinologists. The situation has been refined and developed from time to time, until it has become the safe, sane and logical method of dealing with certain cases. Its foundation is of such long standing and it has met with so many minor alterations which have not changed the fundamental principle that no individual name can be attached to it and still give due justice to the others; so we prefer to call it "The External Ethmo-Sphenoidectomy." In so doing we are considering the frontal a modified ethmoid cell, and such it is.

At first we were concerned to know whether to leave the mucosa of the frontal or not. In a large frontal with a virgin mucosa we were reluctant to remove the lining. Should the artificial opening created into the nares become occluded by granulations a mucocele might develop. Communication with Mithoefer revealed that he often left the mucosa of the frontal intact, while Ferris Smith removes it routinely. Those cases in which we have left the mucosa undisturbed have gotten along as well as the others. We have decided to remove the mucosa in all small accessible frontals. In large or communicating frontals which would not be obliterated by granulations anyway we have left intact unless definitely diseased. The frontal sinus is less subject to infection, as there are less glands in the mucosa.

The factor of entering the ethmoids externally probably has been delayed because of cosmetic reasons. We are able to demonstrate convincingly that the scar produced by the external route is so unobservable as to be no contraindications at all to the operation. Primary union is obtained readily and by cross marks and care in apposition of the skin; the cosmetic result can be made excellent.

Indications, Diagnosis and Symptoms: The type of case lending itself more suitable for this operation is variable. This will depend upon the degree of success enjoyed by the different operators and the familiarity of each with the operation. We used it at first in only a limited number of cases with rather severe symptoms, but later assumed its applicability to numerous situations.

Retrobulbar neuritis is amenable to this type of surgery. The proximity of the sphenoid to the optic nerve makes it vulnerable to prolonged inflammation of the posterior group of sinuses. Sluder preferred to refer to the posterior ethmoids and sphenoid as the posterior group. As pertaining to this situation it is quite applicable. The relationship of sinus disease to retrobulbar neuritis has long been recognized. Statistics as to percentage vary from 3 per cent to 25 per cent of retrobulbar neuritides arising from sinusitis. This is difficult to fix; however, as more is learned of sinusitis it is more generally recognized that disease of the posterior sinus group can and does produce retrobulbar neuritis. In retrobulbar neuritis there is not much to be seen by the ophthalmo-

scopic examination. Where there is reduction of vision with a central scotoma or a markedly enlarged blind spot, it must be taken into consideration. Some cases may improve under conservative care of the sinuses. One case developed retrobulbar neuritis in one eye and cleared up with conservative management, then one month later developed a retrobulbar neuritis of the other side which did not respond to treatment. When the vision was reduced to perception of fingers at fifteen feet it was decided to do the external ethmoidectomy. The vision was regained to 20/20 within four days time. To delay too long means to lose vision. The maculo papillary bundle is the most susceptible to inflammation. The return of vision is directly in proportion to the time and intensity of the inflammation. After atrophy has occurred it is useless to expect much. Some instances have noticed a remarkable gain of vision within forty-eight hours. One case that had blurring of vision for two and one-half months gradually regained visual acuity for forty days when it seemed to become fixed. Needless to say, the cases must be well worked out to exclude multiple sclerosis, brain tumor, syphilis and chronic poisoning from lead, alcohol, tobacco and chemicals, as the diagnosis of retrobulbar neuritis arising from sinus disease is established partially by elimination of other causes. We feel that cocainizing the sphenopalatine ganglion is very helpful in establishing the diagnosis. It also serves as a check as to whether or not your local treatment is producing results.

Bronchitis and Bronchiectasis are now recognized to be commonly due to sinus disease. One can often recognize that a person has had chronic inflammation of the upper respiratory tract by an X-ray of the chest, showing peribronchial thickening and increased density of the peritruncal glands. That the infective material from the sinuses drains into the chest when asleep was proven by the work of Meyer and Quinn.¹⁰ To achieve results in the more advanced cases of bronchiectasis it is often necessary to clean up the sinuses. Often improving the antra will help. If in spite of thorough maxillary sinus surgery and more conservative ethmoid work the condition is stationary, we believe this operation is indicated. Some may wish to try a submucous resection, removal of turbinates or intranasal ethmoid operations and await results. We would prefer, in such advanced cases, to do the external operation at once, knowing we can eradicate prac-

tically all the infected area at once and expedite the patient's recovery instead of retarding it. In one instance, so-called conservative surgery had been tried and the patient remained an invalid with bronchiectasis for twelve years and bedfast for two years. Within two months, after an external operation, the patient was able to become ambulatory and the cough much improved. A tharocoplasty previously tried did not ameliorate the symptoms very much. In less advanced cases the operation is certainly suitable, as such people often spend much worry and consideration of climate changes, at economic loss, for relief. Most cases of bronchiectasis have bilateral sinusitis, so spectacular results cannot be expected by doing one side.

Intense and prolonged headaches, severe and intractable facial pain, and cases that very much resemble *tic douloureux* are very amenable to the external ethmo-sphenoidectomy. It is true that many headache cases have enjoyed benefit from intranasal procedures. When one has the confidence of the patient sufficiently to be certain that they will return for other operative interference or treatment when the conservative measures have been partial failures, it is all right to try them; if not, it is best to proceed at once with the external operation. Too frequently, intranasal operations do not relieve the discharge even though the headaches may be helped. When the pain is rather severe and is so typically described as being in, or behind, the eye, in the face or in the lower occipital region, the indication is to cocaine the sphenopalatine ganglion thoroughly. Cocaine flakes on a fine adrenaline saturated applicator placed on the ganglion gives us definite information. The sphenopalatine neuritis has a direct bearing on chronic sinusitis, particularly of the posterior group. Its manifestations are numerous, such as pain behind the ear, in the neck, in the face, a deep-seated pain in the eye, a dull headache and photophobia. These cases are very grateful for the external ethmoid.

Most of them express relief of the particular type of pain very soon after the operation. In one instance, it persisted for one month after the operation to a degree. Even though this patient had total relief of the pain when the ganglion was cocaineized, it appeared our diagnosis was erroneous: however, she eventually became entirely free of her pain and

has been so for eight months. When there is a neurosis of the Vidian nerve central to the ganglion, cocaine will not relieve the pain. We have not seen such a situation; however, Sluder described some such cases. One case having had a diagnosis of trigeminal neuralgia for three years submitted to this operation for relief of focal symptoms. We were surprised to find that the pain disappeared entirely, making us speculate if more of such cases do not really have a sphenopalatine neurosis or a focal infection with a specification on the trigeminal nerve.

Asthma, when due to sinusitis, is particularly amenable to the external ethmoid. First, it is necessary to determine whether the asthma may be an allergy due to foods, pollen or proteins, or whether it is caused by sinusitis. Ethmoidal disease with polypus formation is the most common type of sinusitis causing asthma. With the development of the new specialty of allergy, physicians are encouraged to indulge in refined detective work to find the cause of asthma when it is often in the sinuses, particularly the ethmoid group. Ferris Smith has convincing reports to show what may be done with asthma and how often it is due to sinusitis. Results cannot be expected unless all the mucous membranes are cleaned out. The acetonic picric acid solution suggested by him assists in doing this. We have operated three cases of advanced asthma having previously had intranasal work by competent men. In these cases, as in several other cases previously operated by competent men, it is surprising to note what a large portion of the ethmoids had apparently been untouched. One case of severe asthma was able to dispense with the use of adrenaline within five days after the operation. Another with symptoms of ten years has been entirely free of asthma since the operation. In asthma, we believe the external operation is indicated because it gives access to the infected and hyperplastic areas provided for by no other methods.

A wide latitude exists in the use of this operation among focal infection cases. Here one cannot be too dogmatic about its use, as it will depend on the individual situation. In osteoarthritis and neuritis we are frequently at a loss to find a focus of infection. Providing the infection is found to exist in the sinuses and providing other methods have failed, it is justifiable to try the external operation. This statement is

based on improvement in nine cases. To recite cures in osteoarthritis is to invite criticism as often bony changes have occurred. Neuritis is more amenable, and in our series four cases have been entirely relieved. Some were partially assisted by the use of a vaccine. Chronic corneal ulcers have been considered by some ophthalmologists to be very rarely due to sinus diseases, while others recite the sinuses as being prominent in the cause of this condition. Our observation would lead us to believe such is frequently the focus of infection in refractory corneal ulcers. One case of bilateral corneal ulcers of eight months standing was relieved entirely by the external ethmoid operation. We believe this operation afforded a better opportunity for cure than more partial procedures. Other types of eye infection, as iridocyclitis and chorioretinitis, may be treated by this method when a sinusitis exists and other focal infection or other causes are excluded. One case shows the value of the external operation over the intranasal operation in this instance. A woman following the influenza developed an acute mastoid which was operated. She then developed diabetes insipidus and was taking large amounts of pituitary extract to control the polyuria. An X-ray of the sella turcica was negative and since the sphenoid was cloudy to X-ray it was decided to open the sphenoid intranasally. This immediately controlled the diabetes insipidus, but did not stop an iritis which she had for eight months. The ethmoids were cleaned as well as possible by the intranasal route. It was then decided to do the external operation. Within four days the iritis was much improved and has not returned. Here it is shown the external operation affords a better opportunity to remove all the focus of infection.

Some obscure gastrointestinal complaints are improved by sinus operations. It would seem that swallowing a large amount of infected material over a period of years might exert itself on the intestinal tract. It is true this is partially digested and detoxified; however, numerous pathogenic organisms may be recovered in the stool of a sinus case, indicating they are not all digested. Most cases of chronic sinusitis give a history of gastrointestinal complaints. The relation of sinus disease to pituitary problems has not been well worked out. Its close proximity to the sphenoid might easily cause disturbance of this gland. Admittedly the intranasal methods

could also be used here providing one wished to attack the sphenoid.

The Operation: Preoperative treatment is essential. We prefer to have the patients very drowsy, thereby getting better effect from the cocaine. Sodium amytal is a great adjunct. It renders them in a dream state where no recollection exists of the operation and it protects against cocaine even more than other barbiturates, as shown by experimentation by Martin.¹¹ If hyoscine is properly balanced with morphine no excessive cortical stimulation is manifest and the drugs act with synergism.

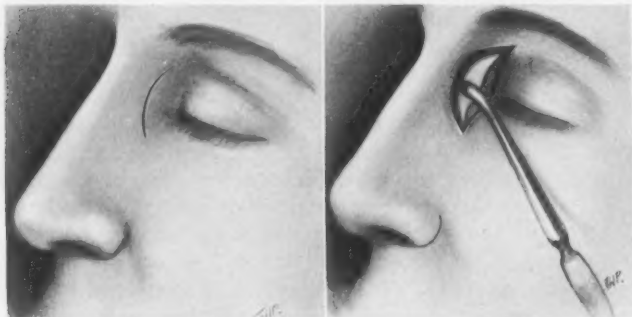


Fig. 1.

Fig. 2.

Fig. 1. The incision.

Fig. 2. Stripping the periosteum off the lacrymal bone and the ascending process of the superior maxilla.

The sphenopalatine ganglion and anterior ethmoidal nerves are cocainized. The infra-orbital, supra-orbital and supra-trochlear nerves are infiltrated with novocaine—adrenaline solution, or in cases sensitive to this drug nupercaine 1:1500 is used. An incision is outlined with the back of the scalpel midway between the inner canthus (see Fig. 1) and the bridge of the nose and cross-marks are made. A lacrimal sac retractor is inserted which helps with hemostasis, then dissection of the periosteum of the frontal lacrymal and nasal bones is carried lateralward (see Fig. 2). The periorbita with the insertion of the superior oblique and the lacrimal sac are displaced lateralward. The Ferris Smith retractor is inserted (see Fig. 3). This is a great help in the operation. A notch fits around

the posterior ethmoidal artery and the blades retract the peri-orbita while the teeth fit under the medial portion of the periosteum. It is not feared if the anterior ethmoidal artery is divided, as only a small amount of hemorrhage occurs. A suction tip is used throughout the operation, as sponging is impossible. The next step is to remove the floor of the frontal sinus and the ascending process of the superior maxilla with Kerrison forceps (see Fig. 3), giving direct exposure to the anterior ethmoidal and frontal sinuses. The lacrimal bone is very thin and if one does not try to enter the ethmoids too far anteriorly it can be done with a crushing movement with



Fig. 3.

Fig. 3. Removing the bone with Kerrison forceps, exposing ethmoid cells and giving access to nasofrontal duct.



Fig. 4.

Fig. 4. Tube inserted in frontal sinus and held in place by suture.

any blunt instrument. The most anterior ethmoidal cells are exenterated under direct vision by Bruenner or Langes forceps. The lamina papyracea is next removed with Luc or Bruenner forceps. This may be carried back as far as necessary for exposure. One-half to two-thirds of the way to the optic foramen is usually sufficient. A bulla frontalis cell bulging into the floor of the frontal often exists. It is next entered and all of the ethmoidal cells removed, carrying the operation back to the anterior sphenoidal wall. This is entered with a Sluder hook and the opening enlarged with a sphenoid punch of the Kerrison or Citelli type. The lining of the sphenoid is removed. For removing areas of mucosa the Kistner blunt end dissector is valuable. The entire cavity is

swabbed with 5 per cent picric acid in 25 per cent acetone, which loosens and removes any remnant of mucosa. We do not suture the stump of the superior oblique back in place, as the eye is kept covered for four days to a week and the annoyance from diplopia thus avoided. There is less chance of supuration if buried catgut is not used. The opening into the nose is enlarged with Freer's nasofrontal rasp or biting forceps and an 8 mm. rubber tube inserted (see Fig. 4) from the nose into the surgical cavity and sutured to the skin to hold it in. The skin is closed with interrupted dermal with care (see Fig. 5). The eye is filled with boric or White's ointment



Fig. 5. Closure.

and an eye pad applied. Omnadin is usually given for one or two doses post-operatively. A dressing is done on the second day and the sutures removed on the second day, and the rubber tube on the sixth day.

COMMENTS.

The external operation has a wide variety of uses. It is a safe, sane and logical method of attacking the ethmoid labyrinth and affords access to the frontal and sphenoid. There is no doubt it is superior to intranasal operations for completeness of removal of pathological material. Photographs of slides are not herein presented because that has been well covered by Simpson and Harris.¹² Observation of our sections reveals them to be of very similar types. The cosmetic feature has probably delayed the development of this

operation. We are convinced that the external scar is so trivial as to be no contraindication. The local immunity of this area is excellent and it is very easy to obtain primary union. The problem of local immunity of sinus mucosa is in its infancy. Fenton and Larsell¹³ are exploring this field and establishing new facts. The more accessible position of the antrasphenoid and frontal make them easier to treat by other refined methods to increase local immunity, such as Wells'¹⁴ method of warm volatile nascent iodine and the instillations of D'Herille's¹⁵ bacteriophage. The ethmoids being a honeycomb-like mass, will never be as satisfactory to treat, even though the cells may be satisfactorily opened by the intranasal route, the mucous membrane cannot be eradicated as well as by the external route.

Diagnosis in these cases must be well established. The X-ray is of value; however, we cannot rely on a single feature for diagnosis. A composite of the history, X-ray, transillumination, nasal inspection and progress are necessary. In some cases it may be important to exclude other features, as brain tumor, allergy, multiple sclerosis, etc. To determine the presence of allergy the method used by Dean,¹⁶ whereby the nasal secretions are centrifuged and an examination made for eosinophils is a good one. The operation is a long, tedious one and requires patience. By combining a Luc-Caldwell operation with the external ethmoid an entire side can be eradicated at one operation. We seldom tie off the posterior ethmoidal artery; however, it gives more exposure to do so. The anterior ethmoid may be severed without much hemorrhage. The instruments devised by Sewall would be of advantage when tying off these arteries.

CONCLUSIONS.

1. The external fronto-ethmo-sphenoidectomy is described. Its evolution has occurred over a period of several years and involves too many rhinologists to be named after one. In the past three years it has had increasing popularity and it is predicted it will have a more universal use.

2. Retrobulbar neuritis, asthma, severe headaches and facial pains, focal eye symptoms, bronchitis and bronchiectasis are indications for this operation. A variable use may be found in the focal infection group dependent on the surgeon.

3. There is no cosmetic contraindication to the external operation, as the scar is trivial and not noticeable. Primary union is readily obtained.

4. By a combination with the Luc-Caldwell operation or a transantral ethmoid the entire group of chronically infected sinuses may be eradicated at one time with very little shock.

5. There is a paucity of material on this subject. We invite further comments or new ideas on the subject.

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Perkins Building.

MIDWESTERN SECTION, AMERICAN CONGRESS OF PHYSICAL THERAPY TO HOLD SPRING MEETING IN INDIANAPOLIS, IND.

The Midwestern Section of the American Congress of Physical Therapy will hold its Spring session on Tuesday, March 13, 1934, at Indianapolis, Ind. The morning will be devoted to clinics at the University and Indianapolis City Hospitals. The afternoon scientific session, commencing at one o'clock, will be held at the Indiana University School of Medicine. The evening session, at eight o'clock, will be held jointly with the Indianapolis Medical Society at the Athenaeum. No registration fee. Dinner at \$1 per plate will be served at the Athenaeum at six o'clock. Cafeteria service at noon at the medical school for visiting physicians and technicians.

RHINOSCLEROMA. REPORT OF A PROBABLE CASE.*

DR. PHILIP S. STOUT, Philadelphia.

Private patient, J. W. T., age 25 years, single, white, American—general extraction, English. Employed in the highway department of a neighboring State since 1928. In contact at times with the road workers, although most of his work is in the office.

Father and mother living and well. Two brothers and one sister living and well. Father had tuberculosis in his youth, but recovered from it; later he was very ill with what was called catarrhal fever, but since then he has been well and constantly at work. Mother is said to have chronic catarrhal condition of the nose, throat and ears.

Past Medical History: Had mumps and chickenpox in infancy. Had influenza in 1918. In 1920 began with some nasal trouble and stomach trouble, both of which have persisted more or less ever since. Stomach trouble was indigestion with eructation of gas almost daily. No nausea or vomiting. No pain.

Nasal trouble started in 1920 with crust formation, which would form over a period of two or three days, when he would pull them out of the nose. These were very foul smelling and quite large and in both nostrils. This condition lasted for three weeks and stopped. The nasal discharge, very slight odor (not crusts), has continued up to the present, using two or three handkerchiefs daily, more or less hawking and expectoration. No blood. The discharge may be mucus or thick yellow pus. There is headache occasionally over the left frontal sinus. Had tonsils removed two years ago.

Examination: Healthy looking young man, average weight 168 pounds, height 70½ inches. He shows no signs of nasal deformity of cicatrices such as are usually seen in a case of rhinoscleroma. (I saw one case several years ago.) Mucous

*Presented before the Philadelphia Laryngological Society, May 1, 1933.

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membrane deep red in color, dry, flecks of mucus on external wall and between ends of turbinates and posterior pharyngeal wall. Transillumination of sinuses shows clear frontals, antra and anterior ethmoids. X-ray of sinuses was not made.

Laboratory Report (Dr. Mulch, Chief Bacteriologist of the State of New Jersey). Material from nose on swab: Staphylococcus aureus and organisms culturally and morphologically identical with encapsulatus rhinoscleromatis. These organisms have been isolated in pure culture several times.

Comment: Here is a young man, American, working with foreigners from time to time, with a chronic nasal condition that shows these unusual germs—encapsulatus rhinoscleromatis. Is it possible that this disease is not as rare as it was thought to be; are these not the same germs as rhinoscleroma; or are there then several manifestations of the action of the rhinoscleroma germs? Is ozena in any way related? Food for thought and further study.

Treatment advised: Vaccine from organisms found. X-ray. Nose cleansed frequently. Note: Vaccine given, some improvement noted.

Presentation of patient. Slides of organism in microscope.
269 S. 19th Street.

THE AMERICAN BOARD OF OTOLARYNGOLOGY.

During 1934, the American Board of Otolaryngology will hold an examination in Cleveland, Ohio, June 11, 1934, during the meeting of the American Medical Association; in Butte, Mont., July 16, 1934, at the meeting of the Pacific Coast Ophthalmological Society; and in Chicago, Sept. 8, preceding the meeting of the American Academy of Ophthalmology and Otolaryngology.

Applicants for certificate should address the Secretary, Dr. W. P. Wherry, 1500 Medical Arts building, Omaha, Neb., for application blanks.

THE ROENTGEN DIAGNOSIS AND TREATMENT OF LARYNGEAL NEOPLASMS.*†

DR. I. SETH HIRSCH and SAMUEL BAUM, New York.

We have endeavored to arrive at some sort of formulation regarding the part which the X-ray should play in the diagnosis and treatment of cancer of the larynx.

At the present time a decision as to the best method of treatment of neoplasms of this organ, whether by surgery alone, by radiation, or by a combination of surgery and radiation is by no means an easy task.

On the one hand, there is the enthusiastic radiation therapist who with high optimism sees the problem practically solved and who already links it with the accomplishment in uterine cancer,¹ and on the other hand is the conservative surgeon, skilled in the performance of a flawless operation, who sees no gain whatever in radiation therapy.² Between these two extremes are those who hold that irradiation methods have a place only in conjunction with surgical methods³ and in inoperable cases,⁴ those who hold that both pre and postoperative radiation is important⁵ and those who stoutly maintain the preoperative radiation is dangerous and postoperative radiation futile.

Further a comparison between the two methods is not easy. The surgical method is old and tried, its rational clear and its technique definite. The radiation method is new; its physiological effects complex and by no means definitely understood, and the technique of its application still within the realm of controversy on many essential points. As far as end results are concerned, it is not too radical a statement to make that in the past the surgical results have been discouraging, the radium results bad and the efforts at X-ray treatment futile.

(1) Coutard; (2) MacKenty; (3) Lewis; (4) Tucker, (5) New and Fletcher.

*Read before Joint Meeting of New York Academy and the College of Physicians and Surgeons of Philadelphia, Sections on Otolaryngology, April 19, 1933.

†From the Dept. of Radiology, Beth Israel Hospital, New York.

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But we are entering a new era, an advance made possible by the guidance of the pathologist on the strength of a classification of neoplastic lesions from the standpoint of radiosensitivity, by the contribution of the surgeon, of an improved surgical technique of approach and by a clearer conception on the part of the radiologist of the fundamental principles governing radiation therapy.

This new era is however predicated on the co-operation between the three, the pathologist, the laryngologist and the radiologist, who are all concerned in this application of radiation as a therapeutic agent. The closest kind of co-operation between them is essential if effects are to be obtained and the treatment is to be properly and honestly applied.

Without a correct diagnosis, without proper control, without a proper selection of cases by the laryngologist, the radiologist works blindly and often to the detriment of his patient; in fact, the radiologist is but the assistant of the laryngologist in these cases. The knowledge of the actual conditions must come from the surgeon, and the keener his diagnostic ability, the closer his scrutiny of the case, the more effective are the results.

What is the function of the laryngologist in this co-operative treatment? The answer will define for us the limitations of the applicability of the radiation treatment. The function of the laryngologist is:

- (A) To select the method of treatment.
- (B) To assist in the control of the case during treatment, and
- (C) To maintain a close scrutiny of the case after treatment.

The function of the pathologist is to express the cellular structure and arrangement of the tumor in terms of radiosensitivity or radiocurability so that it may serve as a guide to the selection of a suitable type of therapy.

In reference to the radiologist, there is this to be said: he must apply the rays with brains and talent, that, although certain fundamentals must be adhered to, which will be indicated later, and which are the essentials of technic, he should

ever bear in mind that he has a living human being to deal with who responds and reacts in manifold ways to the application of this powerful agent.

In the selection of cases for treatment, it is important to take into consideration the following data:

1. Biopsy: type of cell growth; grading of growth; determination of radiosensitivity.
2. Clinical examination: Local—site (extrinsic; intrinsic) tumor bed-lymphatics; Variety—infiltrating, fungating, ulcerating; early, late; Size; Infection; Metastases—glandular involvement. General—age, duration of disease, general systemic condition, sereological examination.
3. X-ray examination.

B. THE X-RAY EXAMINATION.*

The Roentgen study of the soft tissues of the neck and upper respiratory tract is a valuable supplement to the other methods of examination of the structures of the pharynx and larynx.

The examination may be successfully made either fluoroscopically, radiographically, or both methods may be employed, the fluoroscopic permitting a preliminary general survey and the study of the movement of the structures during phonation, deglutition and respiration.

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The Roentgenogram shows the shadows of osteocartilaginous structures, soft tissue structures and an illuminated field due to the air content.

A. The bony and cartilaginous parts shown are: 1. The bodies of the second to the seventh cervical vertebrae. 2. The horizontal ramus of the mandible. 3. The hyoid bone with its cornuae. 4. The thyroid, arytenoid and cricoid cartilages and the tracheal rings.

1. The lower border of the second cervical generally is on a line with the inferior border of the horizontal ramus, the hyoid with the lower border of the third and the tips of the inferior cornuae of the hyoid with the lower border of the fifth. The posterior pharyngeal space parallels the border of the vertebrae to the level of the lower border of the fourth and has a width less than that of any intravertebral space. At the level of the lower fourth it becomes three times as wide. The anterior border becomes the posterior tracheal surface.

2. The horizontal ramus of the inferior maxilla is important as a landmark. In the making of the Roentgenogram the head should be slightly extended so as to elevate the lower jaw slightly. Immediately beneath it are the submaxillary soft tissue shadows.

3. The three parts of the hyoid bone may be shown, but usually the cornuae overlap so that only the quadrilateral shadow of the body and a narrow triangular pointed band of the cornuae extend into the pharyngeal shadow. Occasionally calcification of the thyroid hyoid ligaments may be shown.

4. Before ossification as a rule, the cartilages have the density of the soft tissue structures.

In the female ossification of the thyroid cartilage first shows a linear center along the posteroinferior process on each side. In the male there are three centers of ossification, two along the posterior borders and a third in the anterior part of the cartilage just below the level of the laryngeal prominence. There may be an additional nucleus in the superior border. Additional nuclei of various sizes and shapes may be found distributed irregularly.

Ossification of the cricoid begins slightly later in the upper part of the signet. The anterior portion is the last to ossify.

The composite shadow* produced by the arytenoid, corniculate and cuneiform cartilages is located in the posterior part of the larynx and is triangular in form. The base is continuous with the vocal folds, the blunted apex extends into the shadow of the aryepiglottic folds and the posterior border merges with the margin of the posterior wall of the pharynx, on a level with the crest of the thyroid cartilage and at the point of fusion of the posterior palatine arch shadow with that of the posterior pharyngeal wall. The shadow is usually homogeneous. The arytenoids ossify from below upward. The dense shadow of the arytenoid encroaches upon the illuminated area of the larynx. This is a normal finding.

There is considerable variation in the form and position of the areas of ossification in the cuneiform and corniculate cartilages. Occasionally the cuneiform and corniculate cartilages when ossified may be isolated. The outline of the posterior commissure of the larynx can always be isolated.

For the purpose of analysis the Roentgenogram may be divided into three areas: (1) Suprahyoid; (2) Thyrohyoid; (3) Thyrocricoid.

B. THE SOFT TISSUES.

Suprahyoid: Boundaries:

Above—a line above the superior border of the horizontal ramus of the mandible and crossing above the upper border of the second cervical vertebra.

Below—the hyoid bone and the lower border of the third cervical body.

Behind—the lower part of the posterior pharyngeal wall, the posterior palatine folds and the second and third cervical vertebrae.

Front—the sublingual and submaxillary region, the base of the tongue (forming the anterosuperior wall of the hypo-

*These shadows are not to be mistaken for laryngeal lesions. The chief differential point seems to be that each of these ossifying centers is much more dense than shadows due to tumor formations. The nuclei are multiple, regular, bilaterally disposed and their very density differentiates them from neoplasms.

pharynx) and the concavity of the lateral glossoepiglottic folds uniting the base of the tongue to the suprahyoid portion of the epiglottis.

In this region there is to be noted the uvula, the posterior border of the tongue, the valleculae, the epiglottis, the pharyngopalatine arch.

The submandibular portion of this space shows the convex shadow of the tongue to its insertion into hyoid bone. Underneath are seen two white bands representing the geniohyoid and myelohyoid muscles and a white line—the platysma. The shadow of the skin and subcutaneous tissue forms the periphery.

Thyrohyoid—Boundaries:

Above—the hyoid bone.

Below—the superior border of the thyroid cartilage.

Behind—the superior cornuae of the thyroid cartilage, the posterior pharyngeal wall and the fourth cervical vertebra.

Front—the anterior surface of the epiglottis and the cellular tissue filling the preepiglottic space and the thyrohyoid portion of the epiglottis.

In this region are shown the aryepiglottic folds between the lateral portions of the epiglottis and the arytenoid cartilages, and the transverse projection of the pharyngoepiglottic ligaments at the level of the hyoid bone.

Thyrocricoid—Boundaries:

Above—the superior border of the thyroid cartilage.

Below—the inferior border of the cricoid cartilage.

Behind—the posterior borders of the two thyroid wings, with the inferior cornuae, the arytenoid and cricoid cartilages, and the fifth and sixth cervical vertebrae.

Front—the thyroid portion of the epiglottis, the thyroepiglottic ligament, attached to the anterior border of the thyroid cartilage and the continuation of the cellular preepiglottic space of the thyrohyoid area.

Below the insertion of the thyroepiglottic ligament are the ventricular bands and the vocal cords, the inferior portion of the thyroid cartilage and anterior thyrocricoid space (conus elasticus), the anterior border of the cricoid cartilage and the anterior portions of the tracheal rings.

The ventricular bands appear homogenous as a band-like structure placed horizontally. The lower margin is curved with its concavity downward. The upper borders of these structures fuse into the less dense structure of the vestibule above. They extend from between the angle of the lamina of the thyroid somewhat above its middle and close to the attachment of the epiglottis to the arytenoids. They are continuous above with fibers which reach upward into the aryepiglottic folds and forward to the sides of the epiglottis. This layer forms on each side, the membrane quadrangularis (4704).

The vocal folds can be demonstrated when the ventricles are visible. They appear somewhat like the ventricular folds, but are of a greater density owing to their closer approximation. The upper borders of the vocal folds are more or less clean cut. They appear as a single curved line with the concavity upwards. In this region the anterior and posterior walls of the laryngeal cavity curve backward, thus slightly reducing the anteroposterior diameter of the lumen below the level of the vocal folds.

The lower borders of the shadow of the vocal folds gradually decrease in density passing downwards to a point just above the lower margin of the thyroid cartilage. Here they are lost in the lumen of the larynx.

The inferior border of the thyroid cartilage is usually demonstrable as a line curving downward posteriorly to the inferior cornuae. This curve is usually more pronounced in females. This crosses two sinuous parallel lines corresponding to the upper border of the cricoid.

The posterior boundary is tangential to the anterior surface of the fifth and sixth cervical vertebrae and constitutes a part of the vertebro-laryngeal space. This space, between the vertebral columns and the larynx, is formed by the pharyngeal muscles and aponeuroses, and is included in a wider unilluminated area which corresponds to:

1. Thickened posterior portions of the thyroid laminae in the regions of the insertions of the inferior and superior cornuae.

2. The overlapping of the arytenoids and the thyroid laminae.

3. The inferior segments of the pharyngolaryngeal groove or the pyriform sinus.

The arytenoids form two slight curves somewhat concave behind in the anterior portions of these grooves.



Fig. 1. Normal adult male larynx. There is complete calcification of the signet of the cricoid and the posterior cornuae of the thyroid. The epiglottis is long and in front of it is the illumination of the vallicular area bounded anteriorly by the shadow of the tongue. Extending from the epiglottis to the arytenoid area are the shadows of the aryepiglottic folds. Behind this is the brightly illuminated space of the pharyngeal vestibule, bounded behind by the dark band of the posterior pharyngeal wall. In front of the aryepiglottic folds lies the brightly illuminated area of the laryngeal vestibule bounded anteriorly by the epiglottis. Below the spindle shaped illumination of the ventricle may be seen.

The opening of the esophagus is roughly on a level with the inferior surface of the cricoid and the sixth intervertebral space.

THE ILLUMINATED FIELD.

The illuminated pharyngo-laryngeal field may be divided into four parts, and described in the order of their brightness.

Zone (1) includes the valleculae and the pharyngeal vestibule. The epiglottis projects into this field in the suprahyoid region.

Zone (2) is the spindle shaped ventricle of Morgagni.

Zone (3) is the triangular laryngeal vestibular field between the band below the epiglottis in front and the aryepiglottic folds posteriorly.

Zone (4) is the subglottic field.

Suprahyoid: 1. The vallecular lumen between the epiglottis and the base of the tongue, the lower concave border formed by the glossoepiglottic folds.

2. The beginning laryngeal and pharyngeal vestibules between the base of the tongue, epiglottis and the posterior pharyngeal wall.

Thyrohyoid: 1. The inferior part of the laryngeal and pharyngeal vestibule between the epiglottic wall and the posterior wall of the pharynx.

2. The laryngeal vestibule is limited in front by the epiglottis, behind by the posterior border of the aryteno-epiglottic ligament, below by the band.

The vestibule of the larynx is shown as an irregularly triangular illuminated area whose base is formed by the ventricular folds and the arytenoid cartilages, the anterior border by the epiglottis which extends forward to the ventricular folds, and the posterior border by the aryepiglottic ligaments, cuneiform and corniculate cartilages, extending from the posterior wall of the epiglottis downward to the arytenoid cartilages. The apex of the triangle is at the junction of the anterior wall of the vestibule and the aryepiglottic folds.

There is more variation in the size and illumination of the laryngeal vestibule in males than in females. The depth of the vestibule and its anteroposterior diameter at the level of the ventricular folds is relatively and absolutely greater in the male than in the female.

The surface of the anterior wall of the laryngeal vestibule appears as a sinuous line formed by three curves, due to the posterior projection of the epiglottic tubercle at the level of

the superior border of the thyroid cartilage. This contour varies. It may show only a slight, single curvature with the concavity directed posteriorly. The soft tissues of the anterior wall and its adjacent structures are sharply contrasted against the illuminated area of the cavity.

3. The pharyngeal vestibule is limited in front by the aryteno-epiglottic ligament, and behind by the posterior pharyngeal wall.

Thyrocricoid: From the superior border of the thyroid cartilage to the inferior border of the cricoid and between the anterior and posterior walls, the illuminated cylindrical zone corresponds to the laryngeal lumen. The illumination is diminished at the level of and above the ventricular bands and cords due to the muscular structures. Between the cords and the bands is a spindle shaped area of illumination corresponding to the ventricles of Morgagni.

The laryngeal ventricles are more clearly visible in the female than in the male.

The ventricles are usually irregularly spindle or oval in shape, the more pointed end usually projecting posteriorly. The density of the adjacent structures affects the definition of the ventricles. The lower borders of the ventricles show less curvature than the upper due to the fact that the ventricles undermine the ventricular folds, and that the vocal folds are tenser than the ventricular folds.

In males the ventricles occupy the anterior six-tenths to eight-tenths of the laryngeal cavity, whereas in females one-half to three-quarters represent the two limits. In both sexes the ventricles extend an average of two-thirds of the distance between the anterior and posterior commissures. The ventricles and the ventricular and vocal folds cannot be demonstrated before the age of three years.

The lowest portion of the laryngeal cavity shows as an inverted cone-shaped area of illumination which becomes narrower as it extends downward. There is a slight outward bulging of the anterior wall in the region of the conus elasticus, which is situated between the thyroid and cricoid cartilages. Normally the anterior and posterior walls are sharp in outline and the lumen is homogeneous in illumination.

The pyriform sinuses are not outlined except by contrast methods. They should be sought for in the region corresponding to the posterior part of the thyroid cartilage. The anterior wall appears to pass downward and slightly backward from the lowest part of the epiglottic valleculae. Just below the superior border of the thyroid cartilage the line assumes a gradual curvature downward and posteriorly, terminating just posterior to the upper border of the cricoid cartilage.



FIG. 2. B. B., age 65 years, shows a large circumscribed tumor mass having its origin at the junction of the arytenoid and aryepiglottic fold. It projects upward and forward into the laryngeal vestibule. The ventricular illumination is maintained.

The illumination is somewhat diminished at the level of the inferior portion of the thyroid cartilage due to the superimposition of this cartilage on the superior border of the cricoid.

Just below the vocal cords is the illuminated area of the subglottic region of the laryngeal lumen a continuation below, as the cricoid lumen and the tracheal space.

THE DIAGNOSIS OF TUMORS.

The erosion, infiltration and displacement of the tissues which neoplastic lesions of the larynx produce, are shown

roentgenologically by deviations from the normal of the contours, changes in size, shape, outline, position and relationship of the normal structures, segments (suprahyoid, thyrohyoid, thyrocricoid, preepiglottic and vertebrolaryngeal) and spaces (interosseous, interligamentous and intercartilaginous), and by changes in the illumination of the pharyngo-laryngeal fields.

The relationship of the cartilages of the larynx proper is usually not changed as a direct or indirect effect of neoplastic lesions.



Fig. 3. Fifteen months after X-ray treatment, 26 hours over 26 days. Complete restitution to normal. Clinically well. No evidence of recurrence or metastasis.

The extent of the deviation from the normal by tumors depends on the size, location and degree of extension of a tumor. If the growth is very small and intrinsic, there may be no appreciable change. Tumors of moderate size on the ventricular bands or cords show as irregularities of the outline of the ventricles and as changes in illumination, which may vary from a diminution to the complete obliteration.

Extrinsic tumors at the base of the tongue, valleculae, epiglottis and aryepiglottic folds even when small, produce sufficient changes in outline, and in the illumination of the

pharyngo-laryngeal fields to manifest their presence. When the tumors are large there may result displacements, for instance, of the hyoid, which changes the size of the thyrohyoid space. The epiglottis may be distorted and displaced by tumors or infiltration in the pre-epiglottic space.

The Roentgenogram aids particularly in the diagnosis of tumors in those locations in which laryngoscopy gives insufficient and inconclusive evidence, for instance in tumors of the ventricles, of the pre-epiglottic thyrohyoid space, at the base of the pharyngo-laryngeal groove, of the posterior surface of the cricoid, of the postero-inferior wall of the pharynx and of the esophageal opening.

A fungating tumor shows as a circumscribed shadow projecting into an illuminated space (see Fig. 2). Depending on the position, it may or may not produce a disturbance of the relationship of the neighboring parts—segments and spaces.

Infiltrating tumors deform the contours and increase the size of the shadows and by this change diminish the extent and change the shape of the illuminated fields.

When infiltrating neoplasms involve the epiglottis, thyroid, arytenoid and cricoid cartilages, irregular defects in the shadows of the structures may be visualized. Ulceration and necrosis, the result of secondary infection, produce similar changes.

The edema associated with neoplastic lesions enlarges the normal contours producing a definite loss in definition. Depending on the extent of the edema there is a decrease in the illumination of the pharyngo-laryngeal fields. This change is never as marked as when infiltration exists.

The Roentgen examination is useful before, during and after X-ray therapy.

1. Before Roentgen therapy.

- (a) Roentgen studies are helpful in determining the type of therapy best suited for the case. The type of lesion, whether fungating or infiltrating, its extent, the degree of invasion of the cartilage and the probable point of origin may be determinable, the extension to cartilage, subglottic area, retropharyngeal and laryngeal spaces.

- (b) As a record of structural changes.

2. During Roentgen therapy.

The changes associated with Roentgen therapy may be demonstrated before they are visible by the usual examination. Such changes may permit the control of the dosage. The onset of a local edema, either in the interior of the tumor itself, or in the submucous cellular tissue, either following or preceding the neoplastic degeneration, is an index to the reaction of the tissues to the radiation.



Fig. 4. A. S., age 35 years. Large squamous cell carcinoma of the right ventricular band, arytenoid and fold. There is obliteration of the structural detail of the laryngeal and pharyngeal areas due to a diffuse mass which obscures all the illuminated fields between the superior border of the epiglottis and the inferior border of the cricoid. Above it invades the base of the tongue and the pre-epiglottic space. The thyrohyoid space is widened, the hyoid being displaced upward. The thyroid cartilage is partially destroyed. A tracheotomy had been done 6 months before patient came for treatment.

3. After Roentgen therapy.

The regressive changes may be closely followed. Recurrence of the tumor or cartilaginous necrosis may be determined early.

Having gathered the data, the surgeon is confronted with the problem as to the therapeutic procedure to be followed.

It is not within my province to attempt to evaluate the surgical treatment. It now appears, however, to be the consensus of opinion of surgeons in groups or clinics organized

for cancer treatment, that some adjuvant in the form of radiation therapy, X-rays or radium should play a part in the treatment of intrinsic and extrinsic laryngeal growths.

The treatment with radium has until now in this country been unsatisfactory. This for the most part is due to faulty technique, inadequate dosage and filtration, and underestimation of the extent of the disease, all basically due, however, to lack of group treatment.



Fig. 5. Condition at end of treatment. The epiglottis can now be visualized, but is edematous, as are the aryepiglottic folds. Illumination of the pharyngeal vestibule has returned. There is marked edema of the pharyngeal wall and in the arytenoid area. The laryngeal illumination is still obscured. X-ray treatment, 24 hours over 21 days.

My task is to discuss the treatment with the X-ray. The use of the X-ray as a therapeutic agent in carcinoma of the larynx is not new, but the method of its application has been characterized by the same advances and retreats as has been characterized the history of Roentgen therapy in general.

The first of the modern efforts directed to the eradication of malignant tumors by irradiation was based on the delusion that the administration of a massive dose in the shortest possible time would overwhelm and destroy the tumor. This delusion was based on the hypothesis, unsupported by bio-

logical experiments, that the cancer cell was less sensitive to the radiation than the normal cell. It was soon found that this method was extremely dangerous to the host and that it was impossible by radiation so delivered to completely sterilize the general run of tumors.

As a matter of fact, the sensitivity of a cancer cell of epidermal origin is usually the same or greater than that of the germinal cells of the epidermis.



Fig. 6. Nineteen months after treatment, regression to normal. The sharp borders of the aryepiglottic folds are seen. The thyroid space is of normal size. The pharyngeal walls are normal. Clinically well. No evidence of recurrence or metastasis.

Both being in the same plane and in the center of the irradiated surface, the epidermal cancer should be destroyed if the germinal cells of the epidermis are destroyed.

Recently, on the basis of considerable biological experimentation and practical clinical research, it has been shown that the desired biological reaction is dependent not only on the total energy, but also on the rate at which it is delivered to the tissues.

This time factor more than any other of the numerous factors involved in dosage is concerned with the increase in the

differential effect and the production of the so-called selective action. By the proper adjustment of the rate at which the X-ray is administered to the tissues it is possible to increase the margin existing between the radiosensitivity of the cancer tissue and normal tissue. By this method of application of the radiation the destructive action on the normal epidermis and mucous membrane is a reversible one (through proliferation of the peripheral epithelial cells) while on the cancer cell it is irreversible and permanently destructive.

Further, such a method of administration of the radiation permits the delivery of such quantities or radiation to the tissues as is not possible by any other method and the effects on the neoplasm are more satisfactory than previously obtained.

From the technical standpoint, the methods of radiation must be planned with the same care and attention to details as in the planning of a difficult operation. All parts of a tumor-bearing area must receive a uniform distribution of radiation, with intensities sufficient to accomplish the desired result. The radiation method must be fundamentally adequate to cope with the particular character of the growth, and suited to the particular therapeutic procedure planned for the particular case.

When the lesion is to be treated by radiation therapy only, a certain total dosage is applied; when the radiation is pre-operative, another method of applying the radiation must be adopted, and this is modified in some respects when the radiation is to be applied both pre and post-operatively. The pre and post-operative application of the radiation is modified by the nature of the operation, the characteristics of the growth, the extent of glandular involvement, etc.

Now if a radiation of a certain hardness is given in a certain continuous way, at a certain rate, and a certain total dosage is directed through certain areas of the head and neck, which include the oropharynx and larynx, there follows destruction of the epithelium of the mucous membrane. Such a destruction is temporary and is followed by complete and rapid restitution without permanent after effects. The necrosis and shedding of the mucosal epithelium is associated with the formation of a pseudo-diphtheritic membrane covering the

irradiated parts. But it is impossible to produce this effect on the mucous membrane without producing changes in the skin, so that at about the time the mucous membrane reaction is repaired, a skin reaction appears, an exfoliative epidermatitis appears which runs its course with complete restitution of the skin to normal. It all comes in regular sequence and takes a certain number of days—about six weeks in all. The date of appearance of these reactions is fairly constant.

As a biological control of the dose, attention must be focused on the mucous membrane reaction. Both the time of its appearance and the intensity of its reaction are important as criteria of proper dosage.

A good reaction of the mucous membrane appears to be associated with a satisfactory reaction of the tumor.

Too rapid completion of the dosage may lead to rapid disappearance of the tumor, but be quickly followed by edema, chondronecrosis and recurrence. The greater danger lies in too rapid application and completion of the treatment than in too slow.

The treatment may be followed by certain local and general complications, the most common of which is edema, in and about the neoplasm. The edema is sometimes extensive and where the luminal narrowing is already extensive because of the neoplasm—preparation should be made for immediate tracheotomy when it becomes necessary, or this may be done preliminary to treatment. Dryness of the mouth, perversion of taste and dysphagia may be manifested during the reaction period.

As previously stated, there is no general rule as to dosage, each case presenting individual differences. Suitable adaptations of the method must be made to the peculiar requirements of each tumor.

This is a description of the basic principles and the desired reaction. The reaction may be obtained by a variety of techniques and methods. In X-ray therapy we have been tormented by methods, fixed formulas which their progenitors declare are panaceas, but which time has proved more or less insufficient. The blind following of any dogma is fatal to the spirit of science.

The proper treatment by radiation does not lie in the blind adherence to any one radiological method or routine, provided basic principles are not neglected.*

The secret of success is the very frequent examination of the larynx by both laryngologist and radiologist during the treatment, for it is only by noting the reaction of the normal and pathological tissues to the radiation that the information is obtained which permits individual treatment and the modification of the routine that each case demands.† It is this which constitutes the real and important contribution of the French school to the treatment of cancer in general and the larynx in particular. Mathematics and ionization measurements are not to be decried, but the close study of the patient and the lesion is more necessary.

We have studied thirteen cases (table) (some from our tumor clinic, some from the service of Dr. S. Kopetsky) treated by X-rays alone, five purely intrinsic and eight extrinsic. In all, definite regressive changes took place and in practically all the tumor primarily disappeared. Six are alive and clinically well, three intrinsic and three extrinsic. Two have passed the two year period, one twenty months; two fifteen months and one four months without evidence of recurrence or metastasis. Five are dead, three extrinsic and two intrinsic. Two are alive with recurrences (extrinsic).

The glottic tumors had no evident adenopathy, the subglottic tumors, the tumors of the bands and the cavities, especially when the tumors had become extrinsic, had definite glands.

The recurrences were first observed between the fifth and twelfth months.

The failure to obtain a clinical cure appears to have been due to two major factors: the disease and the dosage.

*Lewis and Widman with a combination of X-rays and radium before and after surgical treatment (early intrinsic 90 per cent, alive and free from recurrence 4/10-5 yr.), advanced intrinsic 63 per cent, bad intrinsic 21 per cent (over 5 yrs.).

†The extension and the accompanying inflammation may make it difficult at first to establish the site of the initial lesion. It is often only during the course of treatment that the true origin can be established and the relationship between radiosensitivity and location expressed. A tumor may so obstruct the laryngeal vestibule as to make it difficult to determine whether it definitely originates from the pharynx or larynx. During the course of treatment, as the tumor regresses, the true origin can be established.

1. (a) The advanced and unfavorable condition of the case, making it impossible to obtain more than temporary alleviation. (b) Involvement of the deeper structures of the larynx, such as muscle, lymphatics, perichondrium and cartilage. (c) The presence of an infected ulcer; the normal tissues are vulnerable to irradiation under these conditions and the normal defensive mechanism appears to be either reduced or absent. Because of this the growth appears to have become relatively resistant to irradiation. Thus the clinical picture is that of rapid recurrence or incomplete destruction of the tumor.

2. Dosage—Damage to the tissue following irradiation, due to: (a) Too rapid and too intensive daily dose. (b) Total dose given over too short an interval. (c) The difficulty of controlling dosage due to impossibility of examining the mucous membrane of the interior of the larynx. (d) Advanced age with the presence of arteriosclerosis interfering with the normal reaction of the tissues, so that the criteria for dosage are inadequate.

On the basis of an analysis of the literature and the study of the small group of cases cited, the following conclusions may be stated as expressing at this time the position of the X-ray treatment.

Intrinsic: Cures may be obtained by X-ray treatment in the cordal, glottic or subglottic, non-infiltrating keratinizing full differentiate squamous cell epitheliomas. The surgical results are equally good, but with a lesser degree of conservation of the voice and a primary operative mortality of not less than 15 per cent.

Postoperative radiation undoubtedly improves the surgical results. If there is a definite recurrence after surgery, the postoperative irradiation may produce a lasting cure.

Roentgen therapy is not suitable for radio-resistant cancer of the cord with fixation by infiltration, perichondritis or involvement of the cartilages. In these cases postoperative radiation improves the chances of a permanent effect, and such combined treatment gives a high percentage of cures.

Tumors of the ventricular bands usually show more or less considerable infiltration, infection and involvement of the car-

tilage. Such tumors are usually more radio-sensitive than the cordal tumors, but the prognosis in these cases is bad due to their tendency to rapid diffusion and metastatic glandular involvement. Roentgen therapy may effect a cure without surgical intervention, but surgery immediately followed by irradiation appears to be the most logical and rational method.

Extrinsic: On the other hand, in extrinsic cancer, the growth not being either sharply defined nor circumscribed, surgery is not likely to produce a permanent result.

In tumors of the valleculae, pyriform fossa, posterior cricoid and other hypo and lateral pharyngeal regions, surgery alone carries a high mortality and offers no guarantee of cure. Pre and postoperative treatment would seem to offer the best chance.

It is generally conceded that not only may such be accomplished in a palliative way in highly malignant lesions, but that inoperable tumors of high grade malignancy with cervical involvement may disappear completely after irradiation.

Van der Wildenberg believes that because there is no way of foretelling the results of irradiation, surgical intervention comes first. Irradiation is indicated (1) in operable cases; (2) when there is doubt that total laryngectomy has removed all the tumor; (3) if there is definite recurrence.

This expresses a fairly rational surgical viewpoint.

The radiologist might answer that there is no way of foretelling surgical results; that statistics prove that in certain types of cancer irradiation gives as good results as surgery. The radiologist takes (1) the inoperable cases, perforce; (2) the cases in which there is doubt that the surgical treatment can effect complete removal. (Preoperative radiation may make the tumor operable and postoperative irradiation may make the results doubly sure.) (3) The cases in which there is definite recurrence after operation. (Irradiation is the only means at our disposal for this group.)

Harmer states that in his hands the percentage of cures in operable cases by irradiation appears at least to be as good as with operations. For the borderline cases, he states that radium or X-ray should always be tried before laryngectomy and believes "the time has arrived when one may ask the

question whether it is ever safe to perform a laryngectomy unless the patient has received preliminary radiation treatment in some form."

Perhaps the fairest statement which may be made is, that in intrinsic radiosensitive lesions X-ray therapy is at present an alternative method to the best surgical procedures. In extrinsic lesions a combination of surgery and radiation therapy will yield the best results. Preoperative radiation is administered through two fields. The entire treatment is spread over 12 to 14 days. The dose given is only a percentage of the dose given when no operation is planned. We have established 3 sets of dosage. The dose preoperative is only 68 per cent of the full dose and the postoperative dose 88 per cent. The operation follows two weeks after the preoperative dose. Preoperative irradiation produces diminution of the tumor in the majority of cases. The ensuing radical operation is not rendered particularly difficult. The healing of the wound is not compromised. From a technical standpoint there appears to be no contraindications to preoperative irradiation.

However, every attempt to substitute excisions by irradiation is justifiable even if the percentage of results of the latter method of treatment are no better than those of the former.

This opinion relates to the value of the radiation technique now followed. That it produces better results than have hitherto been obtained cannot be denied; that by refinement of the present methods and a pooling of the resources of surgery and radiation it may give still better results is a hope capable of realization.

RESULTS OF THERAPY.
ALIVE AND WELL—NO EVIDENCE OF RECURRENCE
6 mos. to 2 yrs.

1. H. Z.	48	Ca. rt. vocal cord and anterior commissure.	Symptom free—24 mos.
2. J. P.	67	Ca. rt. vocal cord.	Symptom free—24 mos.
3. A. S.	35	Ca. rt. band, rt. ventricle, rt. aryepig. fold and rt. arytenoid.	Symptom free—19 mos.
4. M. M.	58	Ca. rt. band.	Symptom free—18 mos.
5. B. B.	65	Ca. rt. band, rt. arytenoid, rt. aryepig. fold, rt. pyriform sinus.	Symptom free—15 mos.
6. F. F.	60	Ca. of rt. arytenoid, aryepiglot-tic fold, band, pyriform sinus; rt. cervical adenopathy.	Symptom free—4 mos.

DIED

1. H. E.	68	Ca. lt. pyriform fossa, lt. cord, ventricle, band.	Symptom free—1 yr. Recurrence—necrosis.
2. M. W.	41	Ca. rt. band, epig. rt. cord, ventricle.	Symptom free—4 mos. Necrosis of cartilage. No evidence of ca. (Autopsy)
3. E. T.	56	Ca. epig. tbc. epig. lt. cord, pharyngeal wall, pyriform fossa.	Symptom free—9 mos. Recurrence—necrosis of cartilage.
4. J. B.	70	Ca. rt. cord.	Symptom free—3 mos. Necrosis, cartilage. Laryngeal edema.
5. A. D.	72	Ca. lt. pyriform fossa, pharynx and lt. pharyngeal wall, lt. aryepiglottic fold.	Symptom free—7 mos. Recurrence and edema.

ALIVE BUT NOT SYMPTOM FREE

1. A. C.	48	Ca. of epig., entire larynx interior.	10 mos.
2. H. B.	42	Ca. rt. side of epig., rt. vestibule, rt. vent. band, aryepig. fold.	Recurrence—extension of tumor. Metastasis to left cervical and superficial deep lymph glands.

RESULTS

	Total	Alive with Recurrence	Alive and Well 1-2 yrs.	Dead
Extrinsic	7	2	2	3
Intrinsic	5	—	3	2
TOTAL	12	2	5 (41.6%)	5

(F. F.) One case advanced extrinsic laryngeal cancer with cervical adenopathy well four months after treatment is not included.

ANALYSIS OF CASES

	Cases	Alive and Well	Alive with Rec.	Dead
Extrinsic	7	2	1	4
Intrinsic	5	3	—	2
Presence of ulceration and infection	6	1	2	3
Mobility of cords impaired	6	2	2	2
Palpable cervical glands	7	2	2	3
Tracheotomy performed	6	1	2	3
Necrosis of laryngeal structures	4	—	1	3

A NEW DILATOR FOR THE PHARYNGEAL ORIFICE OF THE EUSTACHIAN TUBE.*

DR. LOUIS K. PITMAN, New York.

The isthmus and tympanic portions of the Eustachian tube play no part in the opening and closing movement of the tube. They are constantly open. The pharyngeal portion of the tube is the door to the middle ear. It opens and closes—to properly ventilate the middle ear, to sweep away any nasal secretion from the orifice of the tube, and to break up the surface tension of any secretion stretched across the orifice of the tube.¹ Should the pharyngeal portion fail to open on account of adhesions, edema, etc., the middle ear will suffer.

When one examines the nasal orifice of the Eustachian tube with the aid of a nasopharyngoscope, a vertical slit is seen. The tube is closed. During the act of swallowing, or when the patient says "ka," the soft palate rises and there is also visible a concomitant movement of the posterior wall of the pharyngeal orifice of the Eustachian tube. The posterior wall is seen to rise, moving inward and backward, and at the same time the mouth of the tube changes its shape from a nearly vertical slit to a triangular opening, formed by the backward movement of the posterior wall of the closed tube. The anterior wall remains stationary. The inferior wall of the open tube is formed by the stretched inferior commissure.

For a detailed description of the anatomy of the Eustachian tube, refer to the work of W. Sohier Bryant.²

The present method in dilating the pharyngeal orifice of the Eustachian tube consists of passing a direct nasopharyngeal speculum through the mouth and retracting the soft palate forward until the Eustachian tube orifice is brought into view. The conical end of the dilator is passed through the direct nasopharyngeal speculum into the orifice of the Eustachian

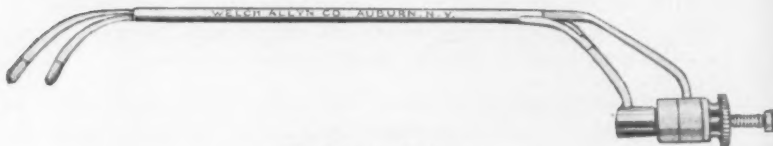
*Read before New York Academy of Medicine, Section on Otolaryngology, May 17, 1933.

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tube. After a few minutes in situ a larger dilator is substituted.

Observation and dilatation of the pharyngeal orifice of the Eustachian tube are greatly limited when attempted through the mouth, for the following reasons:

1. No matter how much the soft palate is brought forward, the orifice of the tube, on account of its anatomical position, cannot be brought into view in all cases.
2. A great amount of cocainization is necessary, and there is also associated a great deal of operative and post-operative discomfort to the patient.



The Pitman dilator.

3. When the soft palate is retracted forward, its movement is arrested; and the movement of the pharyngeal orifice of the Eustachian tube is also arrested, due to the fact that its opening and closing movement works concomitantly with the soft palate. This method of observation leads us to a partial opinion, for we view the orifice of the tube in an arrested state, and hence we cannot see whether the tube opens or closes normally.

4. When the soft palate is brought forward in order to view the tube, the tube is automatically closed, for the triangular cartilage of the Eustachian tube is also brought forward to the anterior wall. When dilatation is attempted, two opposing forces are created, a closing force brought about by the speculum, and a dilating force brought about by the dilator. Very little can be accomplished when two forces work in opposite directions.

To overcome these difficulties, I designed a new type of dilator for the pharyngeal orifice of the Eustachian tube. The dilator, when closed, resembles an ordinary Eustachian cathe-

ter, and is introduced in a like manner, but under the guidance of a nasopharyngoscope introduced into the nasopharynx through the other nostril. When the dilating portion of the instrument is guided into the mouth of the Eustachian tube, outside manipulation of the dilating screw will dilate the orifice of the Eustachian tube. The instrument is kept in situ for about fifteen minutes. Always close your dilator before removing from the nose.

There is no substitute for the nasopharyngoscope when examining the patency of the Eustachian tube. It does not arrest the movement of the soft palate, thus giving an impartial picture of the opening and closing movement of the Eustachian tube.

This instrument is manufactured by the Welch Allyn Co., of Auburn, N. Y., whose advertisement appears on page 4 of this issue, and is sold by all local dealers.

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AMERICAN OTOLOGICAL SOCIETY.

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(Continued from a previous issue.)

Otosclerosis — A Regression? Dr. Louis K. Guggenheim.

The bilateral symmetric involvement, so frequently seen in otosclerosis, suggests a gene-propelled dystrophy rather than a tissue change caused by the venous stasis, irritation from the footplate movement, tensor tympani pull, spontaneous fracture or even a generalized metabolic disturbance. Although these conditions may have an influence upon the bone changes (for example, the appearance or increase of clinical manifestations during puberty, during and after pregnancy, at the menopause, etc.).

In osteodystrophia fibrosa there is a generalized disturbance of metabolism which affects every part of the osseous system. Osteogenesis imperfecta shows generalized metabolic disturbance affecting one of the smallest bones of the body and the densest, without some change occurring elsewhere in the skeletal system.

In certain lower vertebrates, for example, the clupea harengus (herring), the utricle of one side is connected with that of the other by two canals; one passing above the brain, the other beneath, so that endolymph flows freely from one ear to the other. There exists, as it were, a single ear. When we look upon the otosclerotic ear as a lower vertebrate structure in the sense that lower vertebrate genes are present and certain lower vertebrate morphologies develop, it is easier to understand the bilateral symmetric involvement of the "one ear" than such a change in two entirely separated structures.

When in otosclerosis the footplate and annular ligament fuse with the capsule (return to the tissues whence they were derived) we have formed a capsule suggesting that of the lowest vertebrates.

The myxine glutinosa (hog fish) possessing but two canals and a vestibulum, has a cartilaginous capsule entirely devoid of external openings such as oval and round windows. The petromyzon fluviatilis (river lamprey) shows the addition of a sacculous but possesses cartilage capsule but no windows. In the acipenser sturio (sturgeon) we note the addition of a third canal and a lagena cochlea but still no windows have appeared in the capsule.

The cochlea and the two windows are recently acquired structures and we agree with Gray that otosclerosis represents a variation in these recently acquired structures; but we feel that the variation is not an accidental one but rather the result of a regression manifesting itself after the normal genes have expressed themselves. Most frequently the oval window, first to appear, shows an attack by the genes of regression. Not infrequently, however, the cochlea and round window are involved. Rarely do we see involvement of the canal region, which involvement, conceivably, may result from an attack upon the third canal not present in the lowest vertebrates. In a word, the genes of the lowest vertebrates in expressing themselves, tend to obliterate such structures as do not belong to the type of capsule they are destined to build.

The mammalian ear, in its ontogenesis, passes through the various stages of phylogenesis. When the auditory placode invaginates and is cut off from the ectoderm, we have in the auditory vesicle an aural organ similar to that of the lowest forms of life; for example, in the ascidian. The mesenchyme surrounding the vesicle condenses and then differentiates from the remaining

cephalic mesenchyme. No windows are present. At two months (human age) mesenchyme is converted into perichondrium and precartilag. Two weeks later the capsule is of cartilage except where oval and round windows will develop; in these two areas a mesenchymal curtain stretches across. The annular ligament begins to differentiate. The stapedia ring from Reichart's cartilage, which will form the crura, is seen in close relation to the curtain. Under higher magnification we see the mass of mesenchymal cells of the curtain and the cartilaginous ring. The curtain, derived from the capsule, will form the footplate. The annular ligament is beginning to differentiate. At three months (human age) the capsule of mammals has reached full hyaline cartilage development, such as exists in the lowest vertebrates. At this period the stapedia ring has flattened medially to accommodate itself to the curtain (now of precartilag). The annular ligament is differentiating. At four months the ring has fused with the cartilaginous curtain, which we may now designate as the footplate of the stapes. The footplate cartilage is younger than the ring, therefore it stains less deeply. The annular ligament is fully differentiated. Under high magnification we see pluripotential undifferentiated mesenchymal cells on either side of the annular ligament. These cells are of great importance in the development of otosclerosis. At this period the stapes has attained the adult form. Ossification of the capsule is well under way. At four and one-half months ossification of the capsule is progressing rapidly but stops abruptly on either side of the oval window where cartilage persists. The difference in texture between the crura and footplate is hardly discernible. The curtain over the round window has now differentiated into the membrana tympani secundaria.

In fishes the oval window does not develop beyond the membrane-covered opening. In the proteus anguinas (first order of amphibians) the oval window is closed for the first time by a bony operculum. No annular ligament or ossicle is present. A pars initialis cochlea with a membrana tectoria has appeared. Ascending to the menopoma alleghaniense (hell-bender) we find the first ossicle with a footplate articulating by means of an annular ligament with the oval window. Reaching the rana esculenta (edible frog) we find an ossicle (columella) of bone and cartilage with a footplate articulating with the oval window. A round window covered with membrane makes its appearance. Most interesting of all is the presence of the canalis fenestrae ovalis, a passageway from the perilymphatic spaces, which passes through the external capsule wall between fovea fenestrae ovalis and the footplate, to end as a blind sac in the tympanum. This canal originating with the utricular projection of the shark and ray stages has now severed its connection with the endolymphatic spaces and approaches more nearly the form of the fissula ante fenestram of man. Evidently in amphibians and higher vertebrates, the accessory endolymphatic duct is no longer needed. We have thus traced the origin of oval window and the fissula ante fenestram, both of which are so important in the development of otosclerosis.

The site of predilection in otosclerosis is anterior to the oval window: the position of the fissula ante fenestram. This structure which passes from cysterna to tympanum is present in all human embryos and sometimes persists throughout life. At thirteen months of life, the fissula is shown as a well developed passageway just anterior to the footplate. An early focus of otosclerosis developing in the fissula region is demonstrated. Upon higher magnification of the normal fissula we note a heavy cartilage wall and under oil immersion the canal is seen to contain numerous pluripotential undifferentiated mesenchymal cells and other elements. When these mesenchymal cells contain the genes of lower vertebrates, otosclerosis may develop. When inhibited sufficiently to normal genes or when irritation is lacking, otosclerosis may not develop but may be transmitted.

The fissula post fenestram, an indentation of the capsule posterior to the oval window, is entirely a mystery. Bast thinks it may be a drainage point for the perilymph. Under higher magnification the fissula, at four and one-half months in the human, is seen to be lined with fibroblasts, some of which are invading the cartilage of the capsule.

The marrow spaces of normal as well as otosclerotic capsules contain pluripotential undifferentiated mesenchymal cells which under oil immersion are well visualized near an Haversian canal. Some marrow spaces are swarming with these cells.

The pathogenesis of otosclerosis may be briefly described as follows: In the fissula and marrow spaces mesenchyme cells containing the genes of regression proliferate into a mesenchymal sponge. Pressure is exerted. Cartilage cells succumb. Differentiation of the mesenchyme occurs into fibroblasts, histiocytes, osteoblasts, new vessels and sometimes osteoclasts. The adjoining capsular bone undergoes preparedness which is identified by poor staining and the absence of many details noted in the normal bone. This preparedness probably results from pressure, interference with circulation and possibly also from the chemical action of cartilage degeneration products. New vessels from the otosclerosis focus penetrate the prepared capsular bone. Resorption follows. The blue mantled vessels are surrounded by cementum. The so-called giant-cell osteoclasts sometimes seen in resorption areas are more probably phagocyte as the same process of resorption occurs in cases where these cells are not found. Pink-stained osteoid is sometimes found. Osteoblasts in epithelial alignment may be seen but true lamellar bone does not as a rule form. The penetrating newly-formed blood vessels find themselves surrounded by many mesenchyme cells, histiocytes, fibroblasts and osteoblasts. The fibroblasts may lay down connective tissue at the periphery of the resorption spaces. Soon calcium is deposited and we have formed geflechtartig knochen (irregular fibre-bone, braided bone, calcified connective tissue, otosclerotic bone). The resorption areas containing vessels surrounded by cellular elements give rise to the porosity of otosclerotic bone.

Studying the annular ligament region posteriorly and anteriorly, we note a plate of cartilage over the footplate and over the capsule. This tissue is sensitive to mesenchymal attack. In typical otosclerosis, the focus anterior to the footplate sends out myriads of mesenchymal cells (seen swarming through the ligament toward the footplate). An area of resorption in the footplate is seen. The footplate is being transformed into braided bone. Soon the ligament will be obliterated by calcium deposit—the capsule is closed and thus regresses to its lower vertebrate form.

As time goes on more and more fibre-bone is deposited; the focus becomes denser and denser. The resorption spaces lose their rich cellular content and show instead fibrous tissue. The blood vessels become smaller and many disappear.

In conclusion, an objection to the theory of regression: No other instance, in the human, has been found where a tissue has reached normal development and then shown regression to a lower vertebrate morphology. There are many vestigial structures in the human embryo, some of which disappear before birth, others persisting throughout life. Examples are the vomeronasal organ of Jacobson, notochord, fissula ante fenestram, branchial clefts, etc. Fischer, of Vienna, has reported an adult with a third macula, reptilian cristae and other lower vertebrate morphologies. Rutin reported a case with a macula neglecta. The only example found of regression in a normally developed tissue is in a low form of life, the ascidian. This organism when fully developed moves about freely, possesses a brain vesicle, an aural vesicle with otolith and special organs for tactile and light perception. Within a very short time it regularly loses its brain vesicle and all its sense organs and regresses to a sessile organism.

(To be continued in a subsequent issue.)

